

SPECIES OF SCISSURELLIDAE AND ANATOMIDAE FROM SUB-ANTARCTIC AND ANTARCTIC WATERS (GASTROPODA: VETIGASTROPODA)

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ABSTRACT

A systematic revision on the shallow and abyssal species of Scissurellidae and Anatomidae occurring in Sub-Antarctic and Antarctic waters was carried out. This study is based on material from several field trips and museum collections. The shell morphologies of all the species are redescribed and illustrated with scanning electron micrographs. Additional information on the gross anatomy and the radula for seven species is given. A total of six anatomid and seven scissurellid species are recognized as valid in Sub-Antarctic and Antarctic waters, including three new species herein described. Anatomids are represented by the genera *Anatoma* and *Thielella*; the species recognized for the area are: *Anatoma conica* (d'Orbigny, 1841), characterized by having a globular shell, sculptured with strong axial ribs; *Anatoma euglypta* (Pelseneer, 1903), has a biconical, delicately cancellate shell; *Anatoma shiraseae* Numanami & Okutani, 1990, a gradated shell with a distinct spiral ridge on the shoulder and cancellate ornamentation; *Thielella amoena* (Thiele, 1912), is globose, strongly sculptured, and with flared lower portion of aperture; ***Thielella weddelliana*** n. sp. is characterized by having a laterally expanded shell, with rounded whorls, deep umbilicus, and strong axial ribs; and ***Thielella argentiniae*** n. sp. shows a depressed and widely umbilicated shell, with cancellate sculpture. Scissurellids are represented by the genera *Scissurella*, *Ariella*, and *Sinezona*: *Scissurella clathrata* Strebel, 1908, is characterized by having an inflated shell with densely cancellate sculpture; *Scissurella petermannensis* Lamy, 1910, is sculptured with strong axial ribs; *Scissurella obliqua* Watson, 1886, is nearly smooth and has a shallow umbilicus; ***Scissurella malvinarum*** n. sp. also has a smooth shell surface, but the umbilicus is deep and surrounded by 2–6 spiral cords; in *Scissurella supraplicata* Smith, 1875, the shell is inflated and teleoconch I exhibits strong axial ribs; *Ariella subantarctica* (Hedley, 1916), has a depressed shell, sculptured with axial ribs and spiral cords, a prominent umbilical callus, and closed foramen; and *Sinezona mouchezi* (Vélain, 1876), is inflated, sculptured with strong axial ribs, showing a wide umbilicus and a large foramen. The other three scissurellid species previously described from the area – *Scissurella eucharista* Melvill & Standen, 1912; *Scissurella timora* Melvill & Standen, 1912; and *Scissurella medioplicata* Thiele, 1925 – are considered to be synonyms, and *Scissurella dalli* Bartsch, 1903, is considered a *nomen dubium*. As part of this revision lectotypes are designated for *Thielella amoena*, *Scissurella timora*, *Scissurella medioplicata*, *Scissurella obliqua*, and *Sinezona mouchezi*.

Key words: *Anatoma*, *Thielella*, *Scissurella*, *Ariella*, *Sinezona*, Southern Ocean.

INTRODUCTION

In the last years several workers have studied the Scissurellidae and Anatomidae from the southern part of the southern hemisphere: Herbert (1986: South African species), Jansen (1999) and Geiger & Jansen (2004a, b: Australian species), Marshall (2002: New Zealand

species). However, none of these studies included the species from the Sub-Antarctic or Antarctic waters, where these groups remain mainly known on the basis of rather poor descriptions that lack much necessary detail.

A total of 15 nominal species of scissurellids and anatomids are currently known from Sub-Antarctic and Antarctic waters. *Anatoma conica*

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(d'Orbigny, 1841), from the Malvinas (Falkland) Islands, was the first species described from the area. During the XIX century, *Scissurella supraplicata* Smith, 1875, from Kerguelen Islands; *Sinezona mouchezi* (Vélain, 1877) from St. Paul Island; and *Scissurella obliqua* Watson, 1886, from Kerguelen Islands were described. In the first quarter of the XX century, nine additional scissurellid and anatomid species were added: *Scissurella dalli* Bartsch, 1903, from San Jorge Gulf (Argentina); *Anatoma euglypta* (Pelseneer, 1903) from the west side of the Antarctic Peninsula; *Scissurella clathrata* Strebel, 1908, from Isla de los Estados (Argentina); *Scissurella petermannensis* Lamy, 1910, from South Shetland Islands; *Scissurella eucharista* Melvill & Standen, 1912, from Burdwood Bank (Malvinas Islands); *Scissurella timora* Melvill & Standen, 1912, from South Orkney Islands; *Thielella amoena* (Thiele, 1912) from Gauss Station (East Antarctica); *Ariella subantarctica* (Hedley, 1916) from Macquarie Island; and *Scissurella medioplicata* Thiele, 1925, from Kerguelen Islands. After a hiatus of 65 years, *Anatoma shiraseae* Numanami & Okutani, 1990, from G nnerus Bank (East Antarctica), and *Scissurella georgica* Davolos & Moolenbeek, 2005, from South Georgia Islands were added.

With the exceptions of *Anatoma shiraseae* and *Scissurella georgica*, all the remaining Sub-Antarctic and Antarctic species of scissurellids and anatomids were described prior to the invention of the scanning electron microscope (SEM). Consequently, relevant details on shell microsculpture are insufficiently known. This fact resulted in the placement of all species in *Scissurella*; the only exceptions were *Sinezona mouchezi* and *Ariella subantarctica*, which were originally described in *Schismope*. In addition, most of these species were described on the basis of a few specimens, if not from a single one, and subsequent reports of these species are not common in the specific literature of the Southern Ocean (e.g., Hain, 1990; Dell, 1990; Linse, 1997, 1999, 2002). All these facts make it difficult to determine the actual diversity of the group in the area.

We reassess here the species diversity of Scissurellidae and Anatomidae from Sub-Antarctic and Antarctic waters, by means of re-describing and properly figuring the species currently known for the area. All descriptions are based on SEM studies, including the examination of all traceable type material. In addition, the generic placement of the species and their geographic distribution are re-examined.

MATERIAL AND METHODS

This study is based on the scissurellids and anatomids collected during several field trips performed in the southern tip of South America at both Atlantic and Pacific coasts, and throughout the Scotia Arc Islands. Additional information come from the following museum collections: Australian Museum Sydney, Australia (AMS); Koninklijk Belgisch Instituut voor Natuurwetenschappen, Brussels, Belgium (KBIN); Los Angeles County Museum, Los Angeles, California, USA (LACM); Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", Buenos Aires, Argentina (MACN); Museo de La Plata, Argentina (MLP); Mus um Nationale d'Histoire Naturelle, Paris, France (MNHN); Museum of New Zealand Te Papa Tongarewa, Wellington, New Zealand (NMNZ); National Museum of Scotland, Edinburgh, Great Britain (NMSZ); National Museums and Galleries of Wales (NMW); National Science Museum Tokyo, Japan (NSMT); The Natural History Museum, London, Great Britain (BMNH); Swedish Museum of Natural History, Stockholm, Sweden (SMNH); United States National Museum, Smithsonian Institution, Washington, D.C., USA (USNM); Zoologisches Institut und Zoologisches Museum der Universit t Hamburg, Germany (ZMH); Zoologisches Museum, Berlin, Germany (ZMB); Zoologische Staatssammlung M nchen, Germany (ZSM).

Descriptions of the shell (including protoconch) and the radula are based on SEM images. SEM images were captured on various instruments (LEO 435VP, Hitachi 3000N, Zeiss EVO 40XVP). Non-type specimens were coated with gold or gold-palladium and imaged at 10–20 kV, 100–200 pA probe current, and 10 ± 1 mm working distance in high vacuum using the secondary electron detector; instrumentation permitting (LEO, Zeiss), selected quadrants of a four quadrant backscatter detector were mixed with the secondary electron signal at approximately 10–25% to brighten up shadows. In some instances, better images of coated specimens were obtained in low variable pressure environment (30 Pa chamber pressure) at 20 kV, probe current of approximately 100 pA, and 10 ± 1 mm working distance using a Variable Pressure Secondary Electron detector (VPSE: Carl Zeiss, Cambridge). Type specimens were imaged uncoated at 40–70 Pa chamber pressure using the VPSE detector on the Zeiss EVO40 XVP.

Teleoconch I (T1) is the portion of the shell from the end of the protoconch to the onset of the selenizone. Teleoconch II (T2) is the portion of the shell from the onset of the selenizone to the apertural lip.

The indication of size is relative within each of these two families of microgastropods. For instance, Scissurellidae smaller than 1 mm are considered “small”, those of 1–2 mm are of “medium size”, whereas species larger than 3 mm are considered “large”.

The descriptions of the external anatomy are based on gross dissection under stereoscopic microscopy. Additional information on the anatomy of the species comes from hexamethyldisilazane prepared soft parts for SEM. In the anatomical descriptions, “hindgut” is employed to refer to the last portion of the intestine, located below the roof of the pallial cavity, for which the specimens were oriented in frontal view.

Histology of select material was also performed. Either 5 µm serial sections of paraffin embedded material were stained with hematoxylin-eosin. Alternatively, specimens were embedded in JB-4 (Polysciences) medium at 0.5 bars, cut serially at 2 µm with freshly broken glass knives on a Sorval II ultramicrotome, and were stained with either multiple stain (Polysciences) or a 50%–50% mixture of 1% toluidine blue and 1% methylene blue (= Richardson’s stain). Sections were inspected on a Zeiss Axioskop 2 plus with planapochromatic objectives; images were captured with a Zeiss Axiocam HRc digital camera and captured with Zeiss Axiovision LE software (Carl Zeiss, Oberkochen).

The holotype of *Anatoma josephinae* (housed at the Natural History Museum, Gotenburg, Sweden) was examined using a Zeiss DV12 stereomicroscope and a Zeiss Axiocam HRc. The protoconch was inspected under a compound microscope and measured using calibrated Carl Zeiss Axiovision LE software.

In the present paper, Scissurellidae and Anatomidae are used at family-level following Geiger & Jansen (2004a, b) and Geiger & Thacker (2005, 2006), instead as two subfamilies within Scissurellidae as previously frequently considered (reviewed in Geiger, 2003). The family and genus-level names have been treated elsewhere more extensively with respect to diagnostic characters, taxonomic history, and synonymy (Geiger, 2003).

The synonymy listings presented here mainly indicate the application of the name in the

literature. However, many of these works were not illustrated, or the available illustrations are insufficient to allow positive confirmation of the correct attribution of a name to the specimen(s).

Under “Distribution” the geographic area and the bathymetric range from which the species is known is indicated; these data are based on the compilation of previous literature and the new records provided herein. Latitude and longitude inferred with secondary sources from locality names are given in square brackets; approximate coordinates (identified with the ~-symbol) are provided for imprecise locality names.

Abbreviations used: M: monotypy; OD: original designation; sh(s): empty shell(s); sp(s): life collected specimen(s); L. Latin; G. Greek; stn: station.

SYSTEMATICS

Anatomidae McLean, 1989

Diagnosis

Shell 1–11 mm, trochoid biconical, protoconch with smooth, flocculant or reticulate sculpture; slit at periphery, usually open (closed in *Sasakiconcha elegantissima* Geiger, 2006); radula with lateral tooth 5 enlarged by elongation. More comprehensive diagnoses and discussions have been provided elsewhere (Geiger 2003, 2006a, b; Geiger & Jansen 2004a, b).

Remarks

Scissurellidae have the slit or foramen above the periphery and lateral tooth 5 is enlarged by broadening.

Anatoma Woodward, 1859

Type Species (M): *Scissurella crispata* Fleming, 1828: 385, pl. 6, fig. 3.

Diagnosis

Shell 1–11 mm, trochoid biconical, protoconch with smooth or flocculant sculpture; slit at periphery of whorl, open. Flocculant sculpture characterized by small islands of shell material arranged in an overdispersed pattern; although the islands may occasionally touch one another, adjacent islands do not enclose a discrete area, and the width of the

islands along their axis varies by a factor of at least three. More comprehensive diagnoses and discussions have been provided elsewhere (Geiger 2003, 2006b; Geiger & Jansen 2004a).

Anatoma conica (d’Orbigny, 1841)
Figures 1–15

Scissurella conica d’Orbigny, 1841: 470, pl. 78, figs. 7–9; Gray, 1854: 50; Munier-Chalmas, 1865: 396; Paetel, 1888: 289; Rochebrune & Mabilie, 1889: H75; Pilsbry, 1890: 53, pl. 57, figs. 8–9; Carcelles, 1950: 49; Ageitos de Castellanos & Landoni, 1988: 6–7, pl. 1 fig. 4.

Anatomus conicus: Adams H. & A. Adams, 1854: 439.

Scissurella supraplicata Smith: Melvill & Standen, 1912: 345 [non Smith, 1875].

Schizotrochus conica [sic]: Carcelles & Williamson, 1951: 251.

Schizotrochus supraplicata: Carcelles & Williamson, 1951: 251 [non Smith, 1875].

Schizotrochus supraplicatus: Carcelles, 1953: 162 [non Smith, 1875].

Anatoma conica: Lozouet, 1986: 113; Dell, 1990: 76, fig. 128; Linse, 1999: 400.

Scissurella supraplicata: Ageitos de Castellanos & Landoni, 1988: 8 [non Smith, 1875].

Anatoma s.l. conica: Geiger, 2003: 74.

Type Locality

Malvinas (Falkland) Islands [51°30’S, 59°00’W].

Material Examined

Pacific sector of Magellan Region: 46°35’S, 75°30’W, Bahía San Andrés, N. of Golfo de Peñas, Chile, 1 m (1 sh, LACM 73-73). Strait of Magellan: 53°28’48’’S, 70°21’54’’W, Paso Ancho, 92 m (3 sps & 5 shs, ZMH 19588); 53°39’S, 72°15’W, Isla Carlos III, 55 m (1 sh, MLP 12060). Drake Passage: 56°19’30’’S, 67°09’45’’W, 121 m (1 sp, NMSZ 42838). Atlantic sector of Magellan Region: 54°52’S, 65°50’W, Ensenada Patagones, 144 m (1 sh, USNM 845403; 2 shs, LACM 71-305); 55°47’S, 66°17’W, 115 m (4 shs, NMNZ M.242839); Isla de los Estados: 54°54’S, 63°56’W, Punta



FIG. 1. Distribution of *Anatoma conica*. ●: material examined; ○: bibliographic records.

Ventana, 771–903 m (1 sh, USNM 845405; 2 shs, LACM 71-329); 54°50'S, 64°29'W, Cabo San Antonio, 67–71 m (1 sh, USNM 845400); 54°34'S, 64°30'W, Cabo San Antonio, 73–76 m (4 shs, USNM 845402; 5 shs, LACM 71-352); 54°29'S, 64°40'W, Bahía Crossley, 116–20 m (1 sh, USNM 845404); 55°S, 64°48'W, Cabo San Bartolomé, 438–548 m (1 sh, LACM 71-342); 54°29'S, 64°20'W, Cabo Colnett, 109 m (3 shs, LACM 71-314); 54°50'S, 64°10'W, Cabo Kendall, 76 m (1 sh, LACM 71-334). Burdwood Bank: 54°25'S, 57°32'W, 102 m (3 shs, NMSZ 1921.143.597). Shag Rocks: 53°23'S, 42°42'W, 313 m (1 sh, MLP 12061).

Other Literature Records

54°56'S, 65°03'W, E of Tierra del Fuego, 229–265 m; 55°47'S, 66°17'W, off Cape Horn, 115 m (Dell, 1990).

Distribution

Magellan Region, extending eastwards to Shag Rocks. 1–548 m (living specimens rather at 92–121 m) (Fig. 1).

Etymology

Conica: (L.) cone-shaped.

Diagnosis

Shell globular, sculptured with numerous strong axial ribs, fine spiral threads on teleoconch II; protoconch with flocculant ornamentation.

Description

Shell trochiform, globular, inflated, medium size (up to 1.8 mm in diameter), suture approximately one width of selenizone below selenizone (Figs. 2, 4–6). Protoconch of ap-

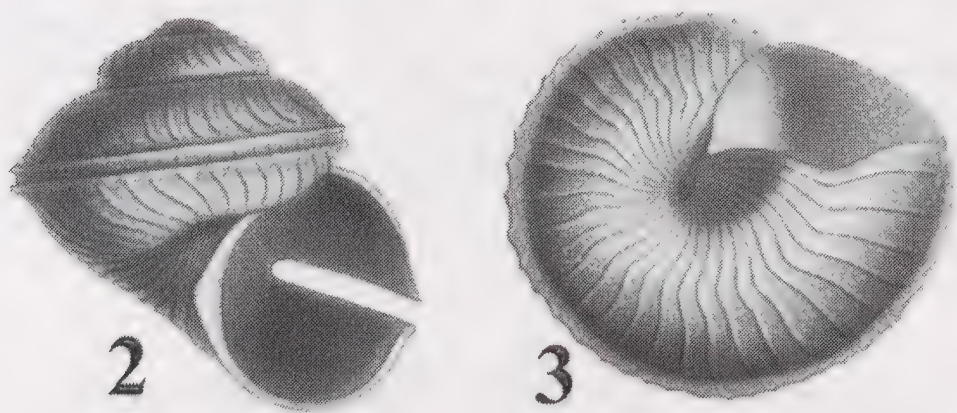
proximately one whorl, 160–205 µm in diameter, with flocculant sculpture; margin of protoconch convex, without apertural varix (Figs. 13–15). Teleoconch I of 1/2 to 2/3 whorls, with single spiral cord in position of selenizone on early teleoconch I, disappearing close to onset of selenizone; 10–21, occasionally bifurcated, axial ribs (Figs. 10–12). Teleoconch II of up to two rounded whorls, with convex shoulder. Shell surface cancellate: axial sculpture of strong ribs, 26 on shoulder of first whorl, 31–34 on last whorl (occasionally bifurcating near selenizone); approximately 60 on base; spiral threads weak, beginning at start of selenizone, gradually increasing in number with growth, approximately 18–20 at apertural margin, 25 on base (Figs. 4–12). Selenizone at periphery, relatively wide, sculptured with low axial ribs, surrounded by narrow keels (Figs. 4–6). Umbilicus open, wide, deep; walls with continuous transition to base (Figs. 3, 7–9); funiculus present. Aperture rounded. Animal unknown.

Remarks

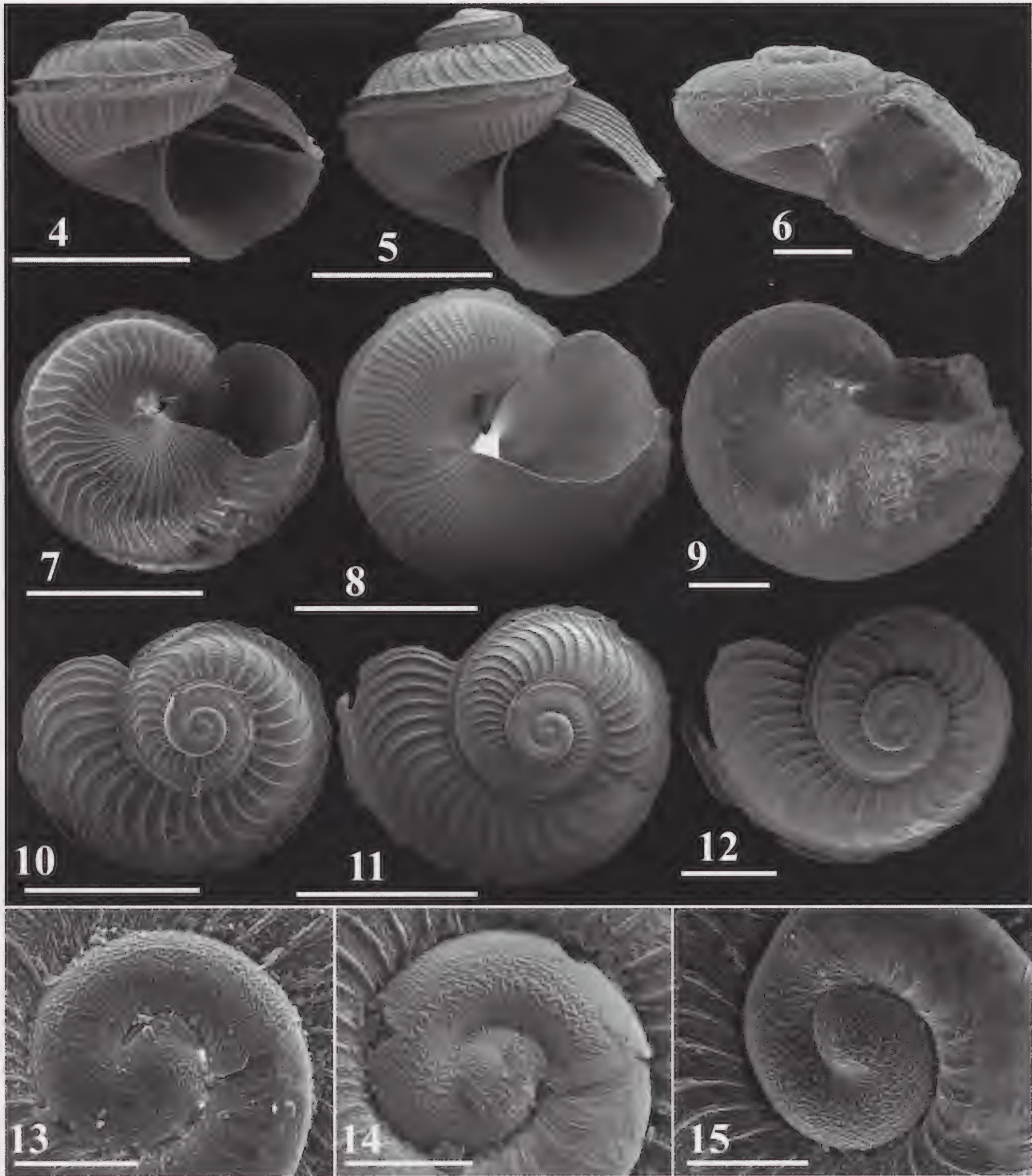
The type material of *Anatoma conica* is probably lost; it was originally deposited in the BMNH (Gray, 1854), but not found currently there (Geiger, pers. obs.; K. Way, pers. comm.). However, we consider the original description and illustrations (Figs. 2–3) to be adequate to recognize this species; in addition, the topotypic specimens examined during this study allowed us to confirm the identity of this taxon.

Anatoma conica is most similar to the Antarctic *Thielella amoena* (Thiele, 1912), from which it differs by a wider shoulder, stronger axial ribs, and flocculent (instead of reticulate) protoconch ornamentation. Other similar species are *Thielella gunteri* (Cotton & Godfrey, 1933) from southern Australia (Geiger & Jansen, 2004a) and *Thielella flemingi* Marshall, 2002, from New Zealand, which also show reticulate protoconch sculpture. *Anatoma conica* can be easily separated from the Antarctic *Anatoma euglypta* (Pelseneer, 1903) by its more globular shell, as opposed the overall biconical shape of *A. euglypta*. In addition, *Anatoma conica* has fewer but more elevated axial ribs, particularly on the shoulder, while the axials are more numerous and the strength of the sculpture is more homogeneous on shoulder and base in *A. euglypta*.

The specimens from Burdwood Bank, previously referred by Melvill & Standen (1912) to *Scissurella supraplicata* (NMSZ 1921.143.596) are here re-identified as *Anatoma conica*.



FIGS. 2–3. *Anatoma conica*. Original figures by d'Orbigny (1841). FIG. 2: Apertural view; FIG. 3: Umbilical view.



FIGS. 4–15. *Anatoma conica*. FIGS. 4, 7, 10, 13: Specimen from 55°47'S, 66°17'W, Estrecho de Magallanes, 115 m (NMNZ M.42839); FIGS. 5, 8, 11, 14: Specimen from 56°19'S, 67°09'W, Drake Passage, 121 m (BMNH 20000096); FIGS. 6, 9: Specimen from 54°34'S, 64°30'W, Cabo San Antonio, Isla de los Estados, 73–76 m (USNM 845402); FIGS. 12, 15: Specimen from 53°23'S, 42°42'W, Shag Rocks, 313 m (MLP 12061); FIGS. 4–6: Apertural view; FIGS. 7–9: Umbilical view; FIGS. 10–12: Apical view; FIGS. 13–15: Protoconch. Scale bars FIGS. 4–5, 7–8, 10–11 = 1 mm; FIGS. 6, 9 = 200 μ m; FIG. 12 = 500 μ m; FIGS. 13–15 = 100 μ m.

Anatoma euglypta (Pelseneer, 1903)
Figures 16–50

Scissurella crispata Fleming: Watson, 1886: 113 [*non* Fleming; in part., specimens from stn 145, R/V Challenger is most likely *Anatoma euglypta*; see Gaillard (1971) for discussion].

Scissurella euglypta Pelseneer, 1903: 17–18, pl. 4, fig. 43; Thiele, 1912a: 187; Thiele, 1912b: 8, pl. 1, figs. 1, 2, 16; Melvill & Standen, 1912: 345; Hedley, 1916a: 85.

Schizotrochus euglyptus: Powell, 1951: 79; Carcelles, 1953: 162; Powell, 1958: 169, 179; Powell, 1960: 126; Arnaud, 1972a: 113; Arnaud, 1974: 641; Egorova, 1982: 11, fig. 72; Cantera & Arnaud, 1985: 32; Castellanos et al., 1987: 58, pl. 1, fig. 1; Ageitos de Castellanos & Landoni, 1988: 9–10, pl. 1, fig. 7.

Anatoma euglyptus [*sic*]: Hain, 1990: 33–34, pl. 1, fig. 1; pl. 28, fig. 7; Numanami & Okutani, 1990: 94–100, figs. 2–5; Numanami & Okutani, 1992: 172.

Anatoma euglypta: Dell, 1990: 75, fig. 129; Numanami, 1996: 12–18, figs. 6A–D; Geiger, 2003: 7; Geiger & Thacker, 2005: 49, fig. 1 [phylogeny].

Hainella euglypta: Bandel, 1998: 37, pl. 12, figs. 5–7.

Type Localities

70°15'S, 84°06'W, 569 m (stn 780, R/V Belgica), 71°19'S, 87°37'W, 400 m (stn 998, R/V Belgica), 70°20'S, 83°23'W, 459 m (stn 1030, R/V Belgica) (OD).

Material Examined

Photographs of one of the syntypes (KBIN). Atlantic sector of the Magellan Region: Isla de los Estados: 54°50'S, 63°50'W, off Punta Fallos, 342–353 m (1 sp, LACM 71-331); 54°55'S, 63°56'W, Punta Ventana, 771–903 m (2 shs, LACM 71-329; 2 shs, USNM 845406). Drake Passage: 56°19'S, 67°09'W,

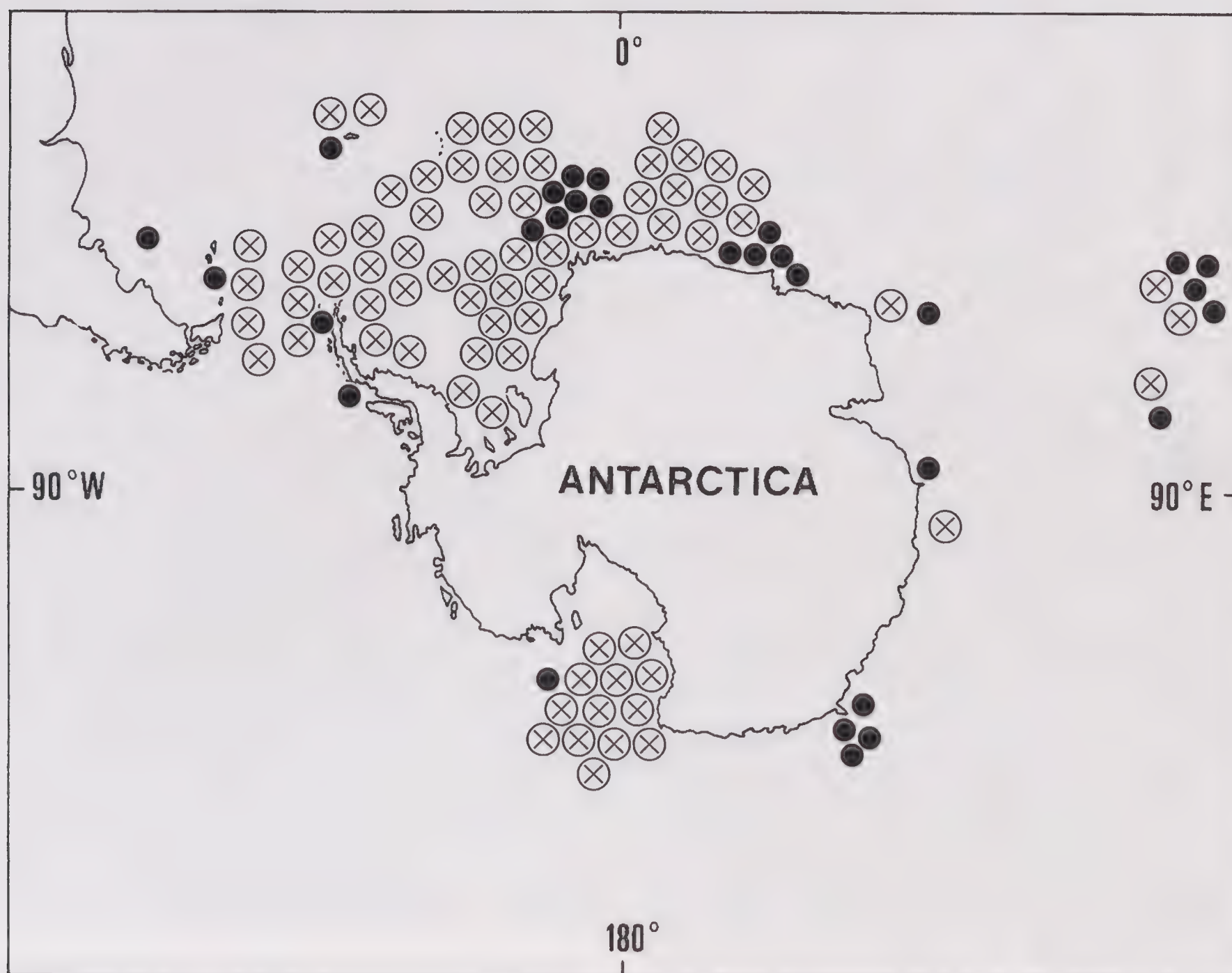


FIG. 16. Distribution of *Anatoma euglypta*. ⊗: material examined; ●: bibliographic records.

121 m (12 sps, BMNH 20000096). Burdwood Bank: 54°30'S, 56°08'W, 286–290 m (8 sps & 5 shs, MLP 120602; 3 sps, ZSM Mol 20021528; 5 sps & 1 sh, ZSM Mol 20021278); 54°25'S, 57°32'W, 102 m (1 sh, NMSZ 1921.143.596). South Georgia: 54°30'S, 35°50'W, 94 m (3 sps, MLP 7281; 4 sps, MACN-In 36273); 53°58'S, 37°09'W, 138 m (2 sps, MLP 7301; 1 sp, MACN-In 36274). South Sandwich Islands: 57°40'S, 26°25'W, 309 m (76 sps & 15 shs, MLP 12063; 9 sps & 2 shs, ZSM Mol 20021094; 20 sps & 3 shs, ZSM Mol 20021351); 57°40'S, 26°24'W, 263–270 m (14 sps & 6 shs, MLP 12064; 4 sps, ZSM Mol 20021459); 57°40'S, 26°27'W, 587 m (17 sps & 3 shs, MLP 12065; 5 sps, ZSM Mol 20021491; 50 sps, ZSM Mol 20021328); 59°54'S, 32°28'W, 521 m (7 sps & 2 shs, MLP 12066; 1 sh, ZSM Mol 20021449); 59°42'S, 27°57'W, 332 m (1 sp, ZSM Mol 20021488); 58°24'S, 25°01'W, 2276 m (2 sps, ZSM Mol 20021126); 58°16'S, 24°53'W, 2940–2945 m (1 sp, ZSM Mol 20021580; 1 sp, ZSM Mol 20021142); 58°25'S, 25°01'W, 2285–2310 m (2 sps, ZSM Mol 20021123); 58°44'S, 25°10'W, 774–756 m (5 sps, ZSM Mol 20041498; 4 sps, ZSM Mol 20041496); 58°25'S, 25°01'W, 2313–2281 m (1 sh, ZSM Mol 20041499). Discovery Bank: 60°08'S, 34°56'W, 374 m (2 sp, MLP 12067; 1 sp, ZSM Mol 20021076). South Shetland Island: 62°40'S, 54°45'W, 210–220 m (3 shs, NMNZ M.242836); 60°39'S, 53°57'W, 2889–2893 m (1 sp, ZSM Mol 20021203; 1 sp, ZSM Mol 20021215); 63°01'S, 61°09'W, 311–365 m (1 sp, ZSM Mol 20010184); 63°26'S, 62°15'W, 119–124 m (1 sp, NMNZ M.242837). Crozet Island: NE of Isle de la Possession, 22 m (2 shs, MNHN); 46°23'S, 51°50'E, 22 m (1 sh, MNHN). Kerguelen Islands: 46°48'S, 70°30'E, 1218 m (1 sh, MNHN). Antarctic Peninsula: 62°55'S, 57°39'W, 214–218 m (1 sh, ZSM Mol 20012475; 1 sh, ZSM Mol 20012470); 63°04'S, 57°31'W, 94–95 m (1 sh, ZSM Mol 20012476); 62°30'S, 56°56'W, 909–911 m (1 sp, ZSM Mol 20012889); 62°55'S, 57°39'W, 214–218 m (2 sps, ZSM Mol 20012887); 63°04'S, 57°31'W, 94–95 m (1 sp, ZSM Mol 20012883); 63°04'S, 57°33'W, 93–97 m (4 sps, ZSM Mol 20012884); 63°04'S, 57°31'W, 94–95 m (5 sps, ZSM Mol 20012888). Weddell Sea: 70°57'S, 10°28'W, 250 m (1 sh, ZSM Mol 20012471); 71°07'S, 11°28'W, 112 m (10 shs, ZSM Mol 20012468); 71°09'S, 13°12'W, 765–840 m (1 sh, ZSM Mol 20012474); 71°09'S, 13°12'W, 765–840 m (1 sh, ZSM Mol 20012886); 70°48'S, 10°42'W, 500 m (1 sh, ZSM Mol 20012473); 70°40'S, 07°40'W, 100 m (1 sh, ZSM Mol 20012472);

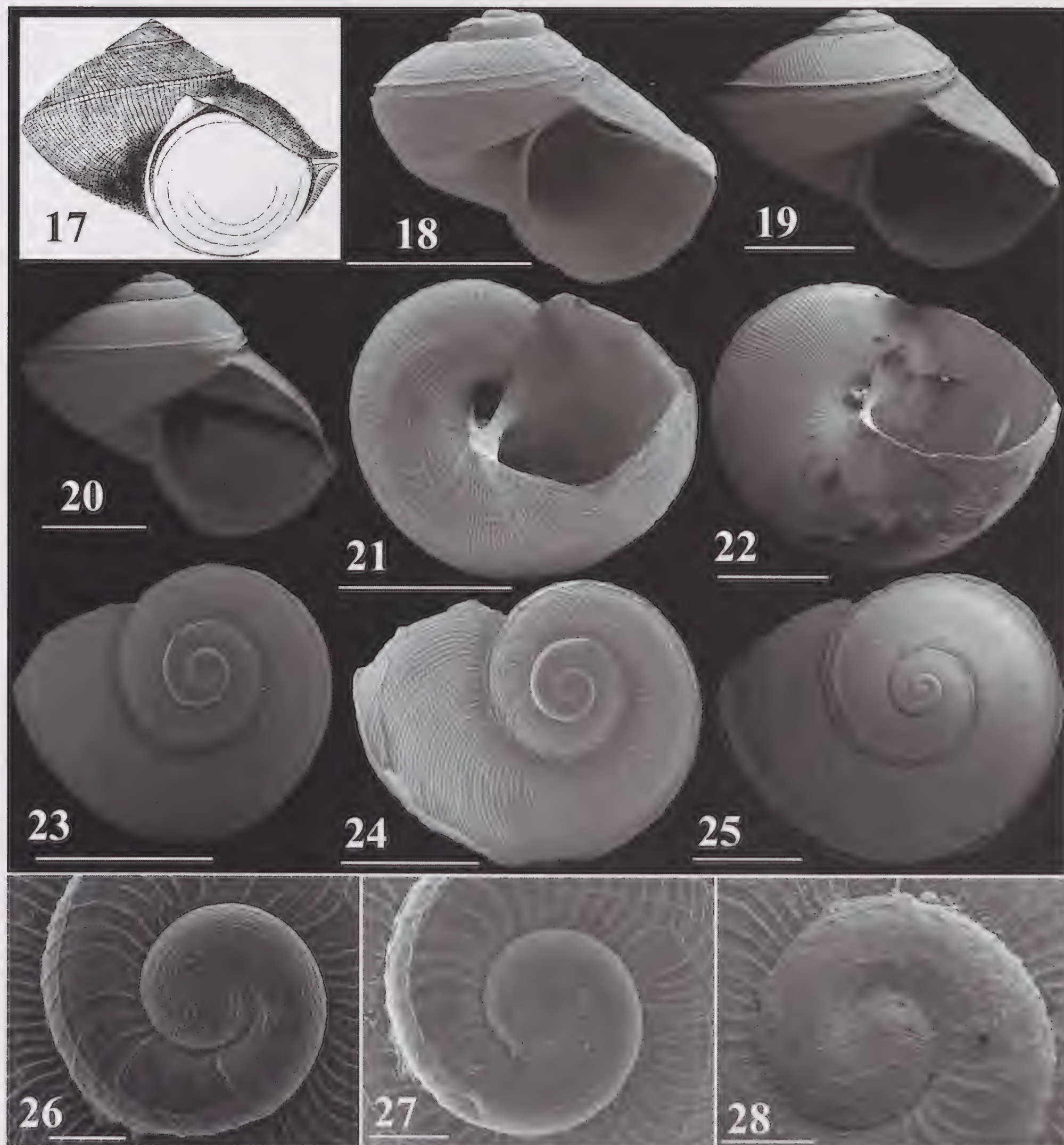
70°49'S, 10°38'W, 316 m (1 sp, ZSM Mol 20012885); 70°50'S, 10°35'W, 251–271 m (1 sh, ZSM Mol 20010077); 65°18'S, 53°22'W, 2081–2087 m (1 sp, ZSM Mol 20021138); 71°18'S, 13°58'W, 1040–1048 m (1 sp & 1 sh, ZSM Mol 20051033; 5 sps, & 1 sh, ZSM Mol 20051016); 70°31.08'S, 14°34.83'W, 4384–4420 m (1 sp, ZSM Mol 20051091); 62°46.7'S, 53°02.5'W, 1579–1584 m (22 sps, ZSM Mol 20051106); 75°34'S, 26°43'W, 229 m (1 sh, USNM 612957); 77°37'S, 43°12'W (1 sh, USNM 612857); 77°40'S, 30°35'W, 384 m (1 sh, USNM 638831). Ross Sea: 72°05'S, 172°08'E, E of Cape Hallett, Moubray Bay, Victoria Land, 348–352 m (2 sps, USNM 904244); 72°05'S, 172°15'E, 392 m (6 shs, USNM 613010); 72°05'S, 172°08'E, 344–351 m (5 shs, NMNZ M.242835); 73°40'S, 175°17'E, Coulman Islands, 521 m (1 sh, USNM 612841); 72°03'S, 172°38'E, 342–360 m (3 shs, NMNZ M.242834); 77°S, 166°E, Scott Base, Cape Armitage, McMurdo Base (2 shs, NMNZ M.218133); 72°20'S, 174°50'E, 465–468 m (2 shs, NMNZ M.242833); 77°05'S, 177°12'E, 362 m (5 shs, NMNZ M.242831); 76°42'S, 179°44'E, 318–472 m (2 shs, NMNZ M.242832); McMurdo Sound: 76°55'S, 164°45'E, SE of Mt Larsen, (1 sh, AMS 31466); 72°08'S, 172°10'E, Cape Hallett, Burton Island, 433 m (2 shs, USNM 878219); 77°26'S, 169°39'E, 321 m (6 shs, USNM 612780). East Antarctica: 66°10'S, 49°41'E, off Enderby Land, 300 m (3 shs, AMS 376618); 66°33'S, 93°09'E, Burton Island, Davis Sea, 80 m (1 sh, USNM 878215); Lazarev Sea: 69°59'S, 08°44'E, 161–185 m (1 sh, SMNH 82903); 69°46'S, 10°01'E, 338–343 m (4 shs, SMNH 82902); 70°00'S, 03°56'E, 568–644 m (20 shs, SMNH 82900); 69°43'S, 10°46'E, 432 m (20 shs, SMNH 82897); 70°19'S, 03°16'E, 191–204 m (30 shs, SMNH 82895); 70°24'S, 06°08'E, 118–126 m (4 shs, SMNH 82896); 69°50'S, 08°00'E, 161–185 m (30 shs, SMNH 82904); 69°59'S, 08°00'E, 161–185 m (30 shs, SMNH 82901; 1 sh, SMNH 82898); 69°57'S, 05°04'E, 210–213 m (8 shs, SMNH 82899); 69°59'S, 05°08'E, 661–742 m (20 sps, SMNH 82905); 69°57'S, 06°20'E, 280–298 m (20 sps, SMNH 82906).

Other Literature Records

Off Argentina: 46°15'S, 60°09'W, 570–600 m (Castellanos et al., 1987). Burdwood Bank, 102 m (Melvill & Standen, 1912). South Georgia: 54°01'S, 36°26'W, off mouth of Stromness Harbour, 155–178 m (Powell, 1951). Antarctic Peninsula: 64°56'S, 65°35'W, Bismarck Strait,

Palmer Archipelago, 93–130 m (Powell, 1951); 68°30'S, 69°W, 64 m (Dell, 1990). Weddell Sea: 70°30'S, 08°20'W, 267 m; 72°52'S, 19°37'W, 481 m; 72°28'S, 17°23'W, 300 m; 72°51'S, 19°20'W, 420 m; 72°53'S, 19°13'W, 401 m; 70°49'S, 10°45'W, 449 m; 72°58'S, 11°07'W, 347 m (Hain, 1989). East Antarctica:

Gauss station (Thiele, 1912a); 65°50'S, 54°23'E, off Enderby Land, 220 m (Powell, 1958); 66°21'S, 138°28'E, off Adelie Land, 640 m (Powell, 1958); Archipel de la Pointe Géologie, between Bernard and Curie Islands, 135–140 m (Arnaud, 1972a); 66°40'S, 139°51'E, Cap Géodésie, 180–200 m (Arnaud,



FIGS. 17–28. *Anatoma euglypta*. FIG. 17: Original figure by Pelseneer (1903); FIGS. 20, 23, 26: Specimen from 72°05'S, 172°15'E, Ross Sea, 392 m (USNM 613010); FIGS. 18, 21, 24, 27: Specimen from 62°55'S, 57°39'W, Antarctic Peninsula (ZSM Mol 20012475); FIGS. 19, 22, 25, 28: Specimen from 54°50'S, 63°50'W, Isla de los Estados (LACM 71-331); FIGS. 17–20: Apertural view; FIGS. 21–22: Umbilical view; FIGS. 23–25: Apical view; FIGS. 26–28: Protoconch. Scale bars FIGS. 18–25 = 1 mm; FIGS. 26–28 = 100 μ m.

1972a); 66°40'S, 139°51'E, Cap Géodésie, 230–250 m (Arnaud, 1972a); 66°40'S, 139°51'E, Cap Géodésie, 170–180 m (Arnaud, 1972a); Breid Bay: 70°10'S, 24°E, 271–310 m (Numanami & Okutani, 1992); 70°09'S, 23°46'E, 275–283 m (Numanami, 1996); 70°09'S, 24°01'E, 295–310 m (Numanami, 1996); 70°08'S, 24°16'W, 270 m (Numanami, 1996); 70°13'S, 24°25'E, 276–289 m (Numanami, 1996). Ross Sea: 72°12'S, 170°20'E, 203 m (Dell, 1990). Kerguelen Islands: 46°47'S, 70°30'E, 1218 m (Cantera & Arnaud, 1985). Crozet Islands: 46°18'S, 51°30'E, 375 m (Cantera & Arnaud, 1985); 46°21'S, 51°33'E, 190 m (Cantera & Arnaud, 1985); 46°18'S, 50°47'E, 290 m (Cantera & Arnaud, 1985); 46°32'S, 51°51'E, 195 m (Cantera & Arnaud, 1985).

Distribution

Circumantarctic, extending northwards up to off Argentina, the Scotia Arc Islands, and the Sub-Antarctic islands Kerguelen and Crozet, associated to Antarctic and Sub-Antarctic waters. 22–4420 m (living specimens: 94–4420 m) (Fig. 16).

Etymology

Eu-: (G.) true; *-glypta*: *Glypho* (G.), incise, cut in.

Diagnosis

Shell large, trochoid-biconical, laterally expanded, sculptured with fine, low, and densely cancellate threads on teleoconch II.

Description

Shell large (up to 11 mm in diameter), trochoid, biconical, wider than high, particularly in early juveniles (Figs. 17–19, 29–31). Protoconch of one whorl, 241–270 µm in diameter, with flocculent sculpture; apertural margin slightly sinusoid, without varix (Figs. 26–28, 38–40). Teleoconch I of 1/2 to 5/8 whorls, sculptured with 15–25 fine axial lines; interstices with fine, low growth lines; axials often increasing in strength with growth (Figs. 23–25, 35–37). Teleoconch II of up to least three whorls (in a 5.6 mm specimen: Fig. 37). Base slightly convex, with approximately 50 fine axial lines in specimens of 1 mm, approximately 150 in specimens of 5.6 mm, crossed by approximately 15 finer spiral threads at 1 mm and 50

spiral threads at 5.6 mm (Figs. 20–22, 32–34). Selenizone at periphery, with distinct axial lamellae, keels low, thin, fragile. Slit open, with margins parallel in small specimens, converging to almost touching at apertural margin in fully grown specimens (Figs. 17–19, 29–31). Umbilicus open, continuously sloping with base, wide in juveniles, progressively narrowing with growth (Figs. 20–22, 32–34). Funiculus present in specimens up to approximate 1.5 mm, not evident in larger ones. Aperture rounded. Operculum multispiral, with central nucleus, yellowish in color.

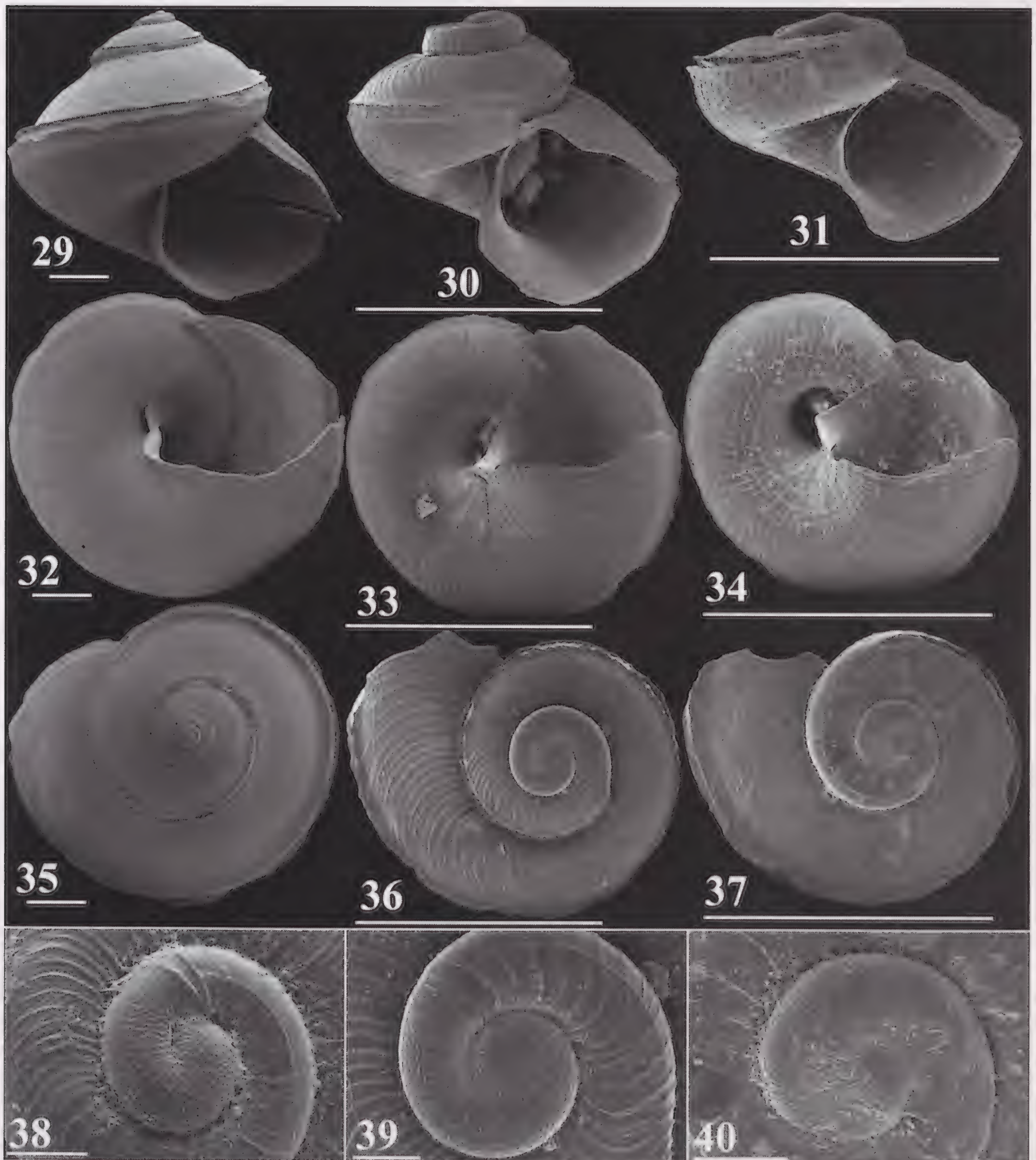
Head-Foot: Color pale cream, uniform. Cephalic tentacles long, circular, densely papillate; papillae tubular, somewhat enlarged at base, about 25–32 µm in length, arranged in verticils (Fig. 46). Eyestalks short, fused at base of cephalic tentacles; eyes black, with lens (Figs. 42, 50). Head separated from foot by wide neck, with one pair of smooth tentacles on each side; anterior neck tentacle foliaceous, posterior neck tentacle cylindrical, sometimes bifurcated (Fig. 42). Three pairs of conical, densely papillate, epipodial tentacles, all with one postero-basal foliated expansion (epipodial sense organ?); first epipodial tentacle divided basally forming two tentacles (Fig. 42). Papillae as in cephalic tentacles (Figs. 44–45). Foot long, narrow, with central longitudinal groove; anterior pedal mucus gland located in longitudinal groove at anterior region of foot. Columellar muscle thick, trapezoidal in outline.

Pallial Cavity: Extending over 1/4 whorl, deeply sinuate in median line, with enlarged mantle border, densely papillate internally. One papillate conical tentacle, as long as depth of mantle cavity, located at end of median sinuation; smaller, smooth tentacles surrounded it at both sides. Two large bipectinate ctenidia spanning most of dorsal mantle cavity (Figs. 41–42). Ctenidia with long, inflated basal third, distally rounded filaments; left ctenidium larger by 10%, with anterior outwards fold, provided with small indentations in margin; right ctenidium without distal fold. Osphradium not found.

Digestive System: Snout broad, tubular, rounded terminally. Jaw plate small, pteriform in outline, paved with rows of rhomboidal shingles, dark brownish in color (Fig. 47). Odontophores large, elongate, enlarged posteriorly, formed by one pair of fused cartilaginous plates (Fig. 50). Radular ribbon longer

than odontophore. Esophagus as large as radula; anterior, medial esophagus walls with transversal folds; anterior, medial, posterior esophagus similar in width. Salivary glands elongate, sac-like, larger than odontophore, pinkish; salivary ducts narrow, long, opening

ventrally into esophagus. Stomach half as long as esophagus. Intestine very long, twisted; hindgut forming two widely open loops, dorsally located. Anus opening into postero-central part of pallial cavity. Digestive gland extending for first 1 1/2 whorls.



FIGS. 29–40. Ontogenetical variability of *Anatoma euglypta*. FIGS. 29, 32, 35, 38: Specimen from 57°40'S, 26°25'W, South Sandwich Islands, 309 m (ZSM Mol 20021094); FIGS.: 30, 33, 36, 39: Specimen from 71°07'S, 11°28'W, Weddell Sea, 112 m (ZSM Mol 20012468); FIGS. 31, 34, 37, 40: Specimen from 70°48'S, 10°42'W, Weddell Sea, 500 m (ZSM Mol 20012473); FIGS. 29–31: Apertural view; FIGS. 32–34: Umbilical view; FIGS. 35–37: Apical view; FIGS. 38–40: Protoconch. Scale bars FIGS. 29–37 = 1 mm; FIGS. 38–40 = 100 µm.

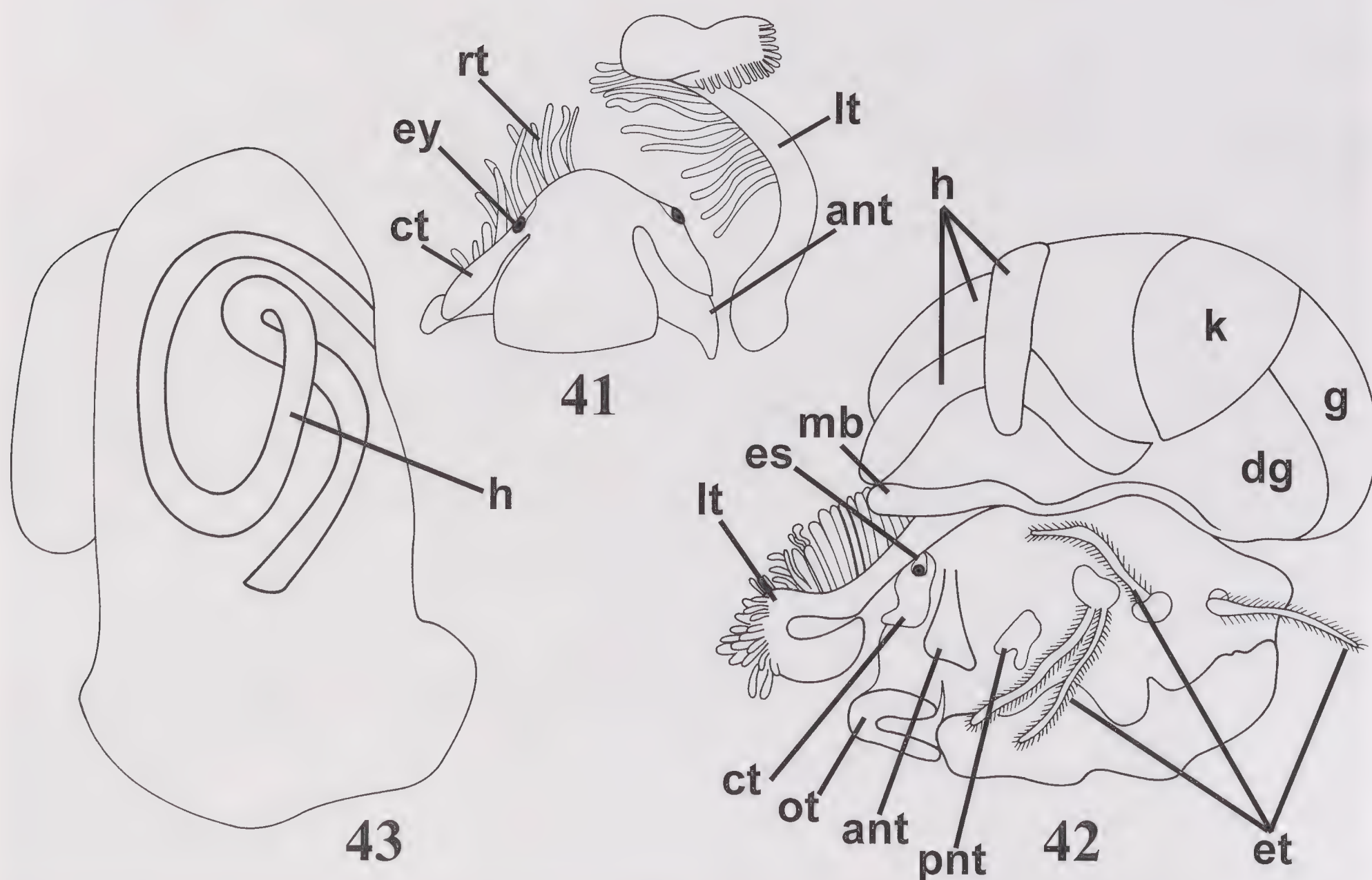
Radula (Figs. 48–49): Rhipidoglossate. Rachidian tooth trapezoidal at base, cusp with denticles parallel to radula rows; central denticle largest, six narrower pointed denticles on each side. Five pairs of lateral teeth; laterals 1–3 similar in outline, overlapping at their widely expanded bases; cusps elongate, tongue-like, with a sharp main denticle, narrower, slightly curved denticles at both sizes: 6–7 on outer side, 4–5 on inner side; fourth lateral tooth narrower than laterals 1–3, with one sharp main denticle, 3–5 additional tiny denticles on outer side; lateral tooth 5 claw-shaped, well separated at base from other laterals, with one main terminal denticle, several smaller denticles on both sides. Marginal teeth numerous (~30), long, narrow, becoming more delicate towards edge of radula; first marginal tooth enlarged laterally at base; shaft, cusp similar to that of remaining marginal teeth.

Nervous System: Pair of fused cerebro-pleural ganglia located on sides of buccal bulb; pedal ganglia large, located ventral to oral tube.

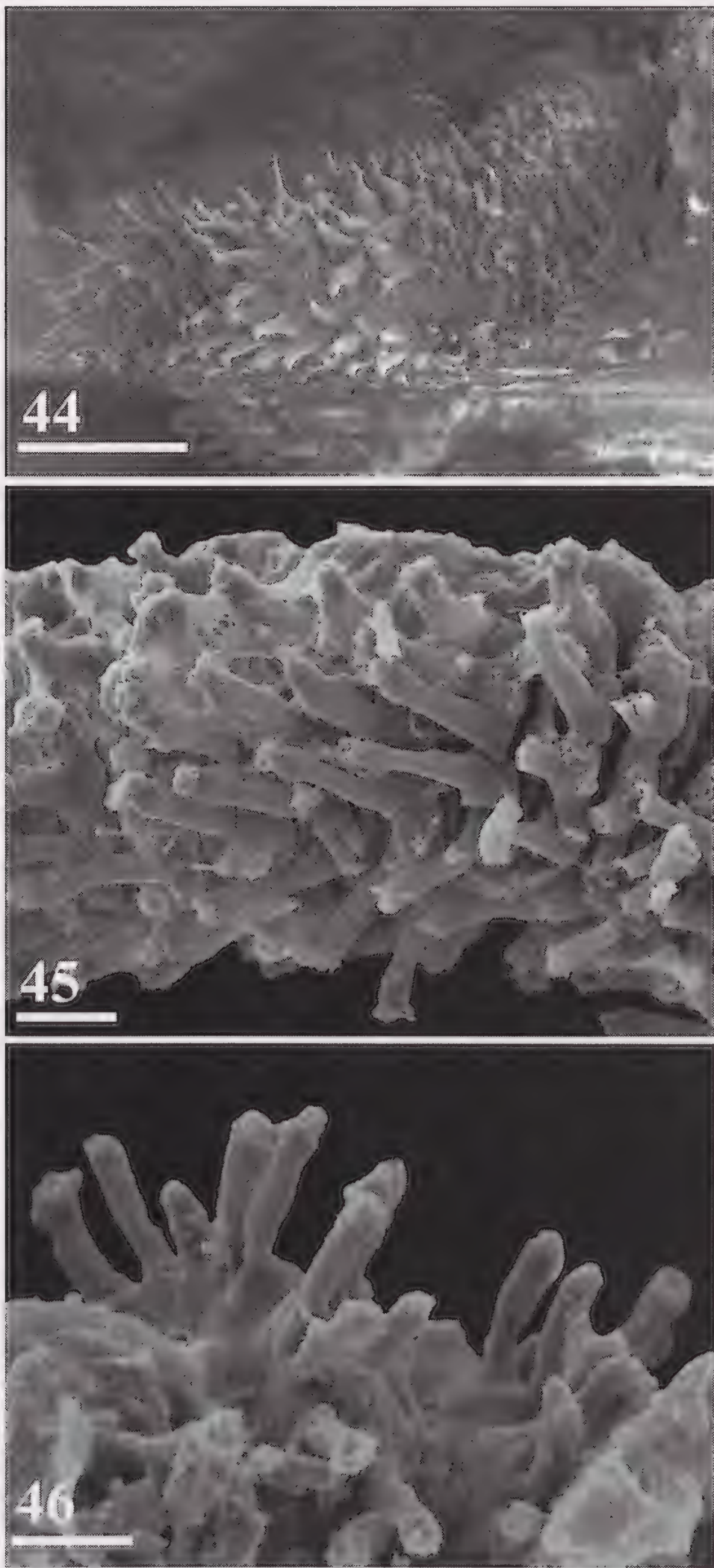
Remarks

The type material of *Anatoma euglypta* is housed in KBIN. Photographs of one specimen were examined during this study. The specimen corresponds well with the original illustration as well as with what is generally referred to as that species (see synonymy above). As we have not been able to personally examine the type material, we prefer not to designate a lectotype.

Anatoma euglypta is the largest of all anatomid species with up to 11 mm shell size. The Antarctic *Anatoma shiraseae* Numanami & Okutani, 1990, differs from *A. euglypta* in having a keel on the shoulder, a distinctive constriction below the selenizone, and coarser sculpture. *Thielella amoena* (Thiele, 1912) has a more globose shell, which is as wide as high, a reticulate protoconch, and fewer and more prominent axial lines than *A. euglypta*. *Anatoma conica* has a globose shell outline, the shell sculpture is much stronger and less dense and the suture is deeper.

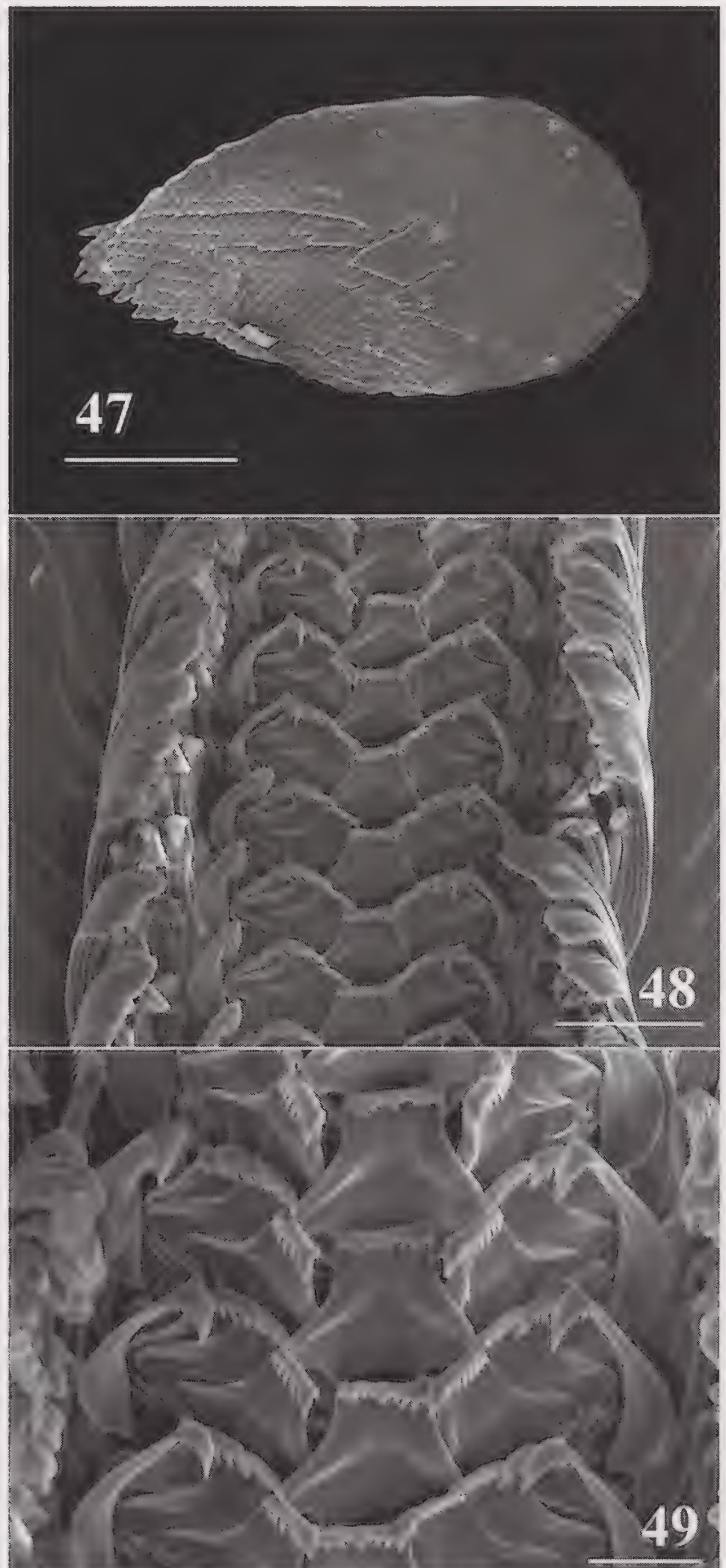


FIGS. 41–43. *Anatoma euglypta*. Anatomy. FIG. 41: Frontal view; FIG. 42: Lateral view; FIG. 43: Detail of hindgut. ant: anterior neck tentacle; ct: cephalic tentacle; dg: digestive gland; es: eye stalk; et: epipodial tentacle; ey: eye; g: gonad; i: intestine; k: kidney; lt: left ctenidium; mb: mantle border; ot: oral tube; pnt: posterior neck tentacle.



FIGS. 44–46. *Anatoma euglypta*. FIG. 44: General view of epipodial tentacle; FIG. 45: Details of epipodial tentacles; FIG. 46: Detail of cephalic tentacle. Scale bars FIG. 44 = 100 μ m; FIGS. 45–46 = 20 μ m.

Anatoma euglypta resembles in general anatomy to *Anatoma yaroni* Herbert, 1986, *Thieleella reticulata* Bandel, 1998 (identified by Sasaki, 1998 as *Anatoma* sp.), and *Anatoma* sp. of Strasoldo (1991). *Anatoma euglypta* differs from *A. yaroni* in having the postero-basal expansion of tentacles (epipodial sense organ?) in the three epipodial tentacles instead only in the two latter as in *A. yaroni*, and in having three



FIGS. 47–49. *Anatoma euglypta*. Radula and jaw plate of specimens from 57°40'S, 26°25'W, 309 m (MLP 12063). FIG. 47: Jaw plate; FIGS. 48–49: Radula; FIG. 48: General view; FIG. 49: Detail of central and lateral teeth. Scale bars FIG. 47 = 100 μ m; FIG. 48 = 50 μ m; FIG. 49 = 20 μ m.

pallial tentacles instead of only one, as reported for *A. yaroni* by Herbert (1986). Five pairs of epipodial tentacles were reported for *Thieleella reticulata*, whereas only three pairs are present in *A. euglypta*. Strasoldo (1991) noted an anterior threefold tentacle, with an epipodial sense organ; a second threefold group is situated further posterior, and additionally a single tentacle on the left side is encountered.

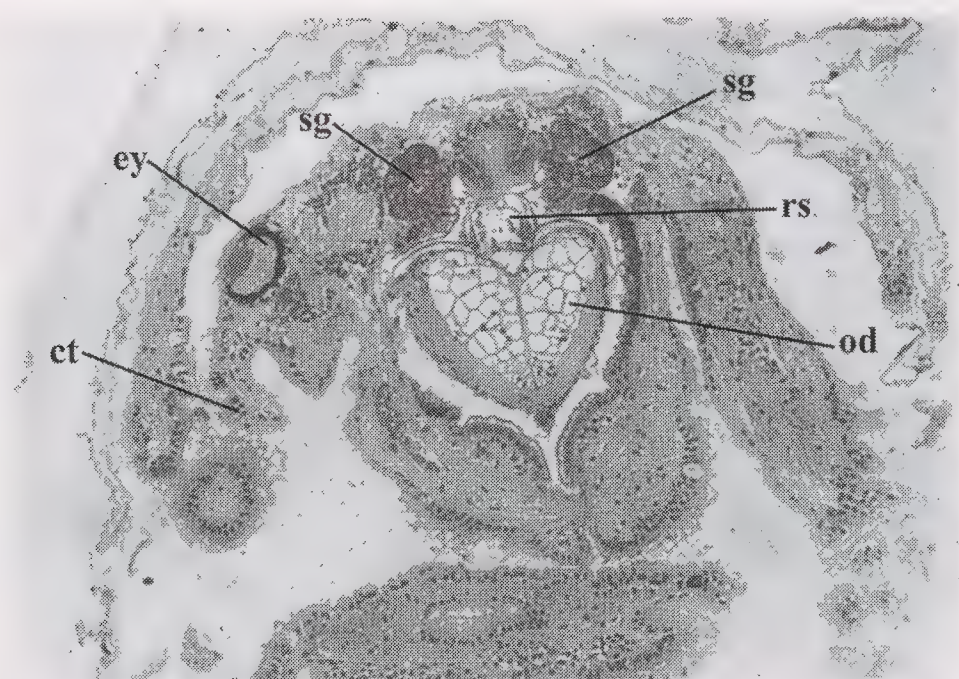


FIG. 50. Histological section of the anterior part of *Anatoma euglypta*. ct: cephalic tentacle; ey: eye; od: odontophore; rs: radular sheath; sg: salivary gland.

The morphology of the radula in *Anatoma euglypta* is very similar to that of *Anatoma baxteri* McLean, 1984 (Geiger, 2003: fig. 16F), *Anatoma yaroni* (Herbert, 1986: figs. 1–2), and *Thielella reticulata* (Sasaki, 1998: fig. 43g, h as *Anatoma* sp.), but in the former, lateral tooth 5 is narrower

and claw shaped in outline. The illustration of the radula of *A. euglypta* provided by Numanami & Okutani (1990: fig. 5; refigured in Numanami, 1996: fig. 6D) was imaged in the anterior, worn region; the more rounded tooth morphology is due to wear and is taxonomically insignificant.

Anatoma shiraseae Numanami & Okutani, 1990
Figures 51–55

Anatoma shiraseae Numanami & Okutani, 1990: 102–104, figs. 14–16; Numanami & Okutani, 1992: 172; Numanami, 1996: 20–21, figs. 9A–C.

Anatoma s.l. *shiraseae*: Geiger, 2003: 75.

Type Locality

Günnerus Bank, Antarctica [68°23.5'S, 24°07.5'E], 281–282 m (OD).

Material Examined

Holotype (NSMT-Mo 69097) and paratype (NSMT Mo. 69098).



FIG. 51. Distribution of three anatomid species: *Anatoma shiraseae* (◆); *Thielella amoena*, material examined (⊗) and bibliographic records (●); *Thielella weddelliana* (♣); *Thielella argentinae* (*).

Distribution

Known only from the type locality (Fig. 51).

Etymology

Named for the icebreaker *Shirase*.

Diagnosis

Shell large, biconical, with a prominent spiral ridge on shoulder, and densely cancellate sculpture.

Description

Shell large (up to 4.2 mm in diameter), biconical (Fig. 52). Protoconch of 1 1/8 whorls,

244 μ m in diameter in the holotype, with flocculant sculpture, rounded margin (Fig. 53), and no apertural varix. Teleoconch I of 3/4 whorls, sculptured with low axial ribs, two spiral cords in position of selenizone (Fig. 55). Teleoconch II of up to 2 1/4 whorls. Shoulder with many fine axials, approximately 95 on last whorl, intersected by approximately 21 radials of same strength, producing cancellate pattern (Figs. 52, 55). Shoulder with distinct, broad spiral ridge. Base with similar spiral ridge below selenizone (Fig. 52). Base with approximately 115 fine axials, 29 somewhat stronger spirals threads. Umbilicus wide, open, sloping continuously with base (Fig. 54). Parietal portion of aperture slightly flared; no funiculus. Aperture subquadratic. Selenizone at periphery with fragile distended keels. Slit open,



FIGS. 52–55. *Anatoma shiraseae*. Holotype (NSMT-Mo 69097). FIG. 52: Apertural view; FIG. 53: Protoconch; FIG. 54: Umbilical view; FIG. 55: Apical view. Scale bars FIGS. 52, 54–55 = 1 mm; FIG. 53 = 100 μ m.

margins constricting anteriorly (Fig. 52). Operculum corneous, multispiral, slightly smaller than aperture. Animal unknown.

Remarks

The placement of the species in either *Anatoma* or *Thieleella*, distinguished by protoconch sculpture, could not be resolved from Numanami & Okutani's (1990) original description, because no SEM images of the protoconch were provided. We examined the holotype by SEM, showing flocculant protoconch sculpture (Fig. 53), which confirms its placement in *Anatoma*.

The body of the wet preserved holotype of *Anatoma shiraseae* was removed by DLG almost completely except for the very tip of the visceral mass. The uncoated shell was imaged by variable pressure SEM. The animal had distinctly recognizable eggs. The paratype shell had been coated for SEM by the original authors, but was partially broken prior to examination by SEM (K. Hasegawa, pers. comm.). The pieces show the diagnostic keel on the shoulder of the shell, but the protoconch is missing from the remains.

Thieleella Bandel, 1998

Type Species (OD): *Scissurella amoena* Thiele, 1912.

Diagnosis

Shell 2–5 mm, trochoid biconical, slit at periphery of whorl, open. Protoconch with reticulate sculpture. Reticulate sculpture is composed of small stretches of shell material varying in width by less than a factor of two, and adjacent stretches of shell material enclose a discrete area. More comprehensive diagnoses and discussions have been provided elsewhere (Geiger 2003, 2006b; Geiger & Jansen 2004a).

Remarks

Bandel (1998) erected the genus *Thieleella* for the higher than wide anatomids, with “scalar whorls”, laterally placed selenizone with lamellae, and reticulate protoconch. As previously indicated by Geiger (2003), the three first characters are not exclusive for *Thieleella* and they are also present in *Anatoma*. Thus, from the original description, the only character on which *Thieleella* is based is the protoconch

ornamentation: *Thieleella* has a protoconch with reticulate protoconch, whereas it is smooth or flocculant in *Anatoma*. The subtle distinction between reticulate and flocculant protoconchs was first noted by Bandel (1998), and has been confirmed by Marshall (2002), Geiger (2003, 2006b), and Geiger & Jansen (2004a).

The distributional ranges do not represent a difference between species of *Anatoma* and *Thieleella*: both genera are virtually worldwide distributed and appear from shallow to abyssal waters.

Three species of *Thieleella* for which the anatomy is known [i.e., *T. amoena*, *T. weddelliana* (this study), and *T. reticulata* (fide Bandel, 1998)] lack pigment in the area where eyes are usually found. This character was considered by Geiger (2003) as a potential additional character to diagnose *Thieleella*. Subsequently, Geiger (2006b) discussed and dismissed this character, because there is a member of *Thieleella*, *T. baxteri* (McLean, 1984), with distinct pigmentation in the eye region, and an *Anatoma* species, *Anatoma janetae* Geiger, 2006, seems to be functionally blind.

The examination of the radula of *Thieleella amoena* (type species) and *T. weddelliana* during this study did not provide any additional differences to separate this genus from *Anatoma*.

Even when more characters than those originally employed by Bandel (1998) for the description of *Thieleella* are considered, the only one that remains to separate this genus from *Anatoma* is the protoconch ornamentation. Although protoconch ornamentation is species-specific, there is clear evidence of homoplasy for particular protoconch types (Geiger, 2003). It suggests that the protoconch ornamentation found in the species assigned to *Thiellleela* might not diagnose a clade, but is only one particular variation present among *Anatoma* s.l.-species. However, we prefer to conservatively retain both genera, until some additional evidence becomes available, as done by Marshall (2002), Geiger (2003), and Geiger & Jansen (2004a).

Thieleella amoena (Thiele, 1912)
Figures 51, 56–70

Scissurella amoena Thiele, 1912a: 187, pl. 11, fig. 11; Thiele, 1912b: 9, pl. 1, fig. 17.
Schizotrochus amoena [sic]: Carcelles, 1953: 161.

Schizotrochus amoenus: Powell, 1960: 126; Egorova, 1982: 11, fig. 71; Ageitos de Castellanos & Landoni, 1988: 10.

Anatoma amoena: Lozouet, 1986: 112; Dell, 1990: 75, fig. 130; Numanami & Okutani, 1990: 100–102, figs. 9–13; Numanami & Okutani, 1992: 172; Branch et al., 1991: 47, 58, 62; Numanami, 1996: 18–19, figs. 8A–E.

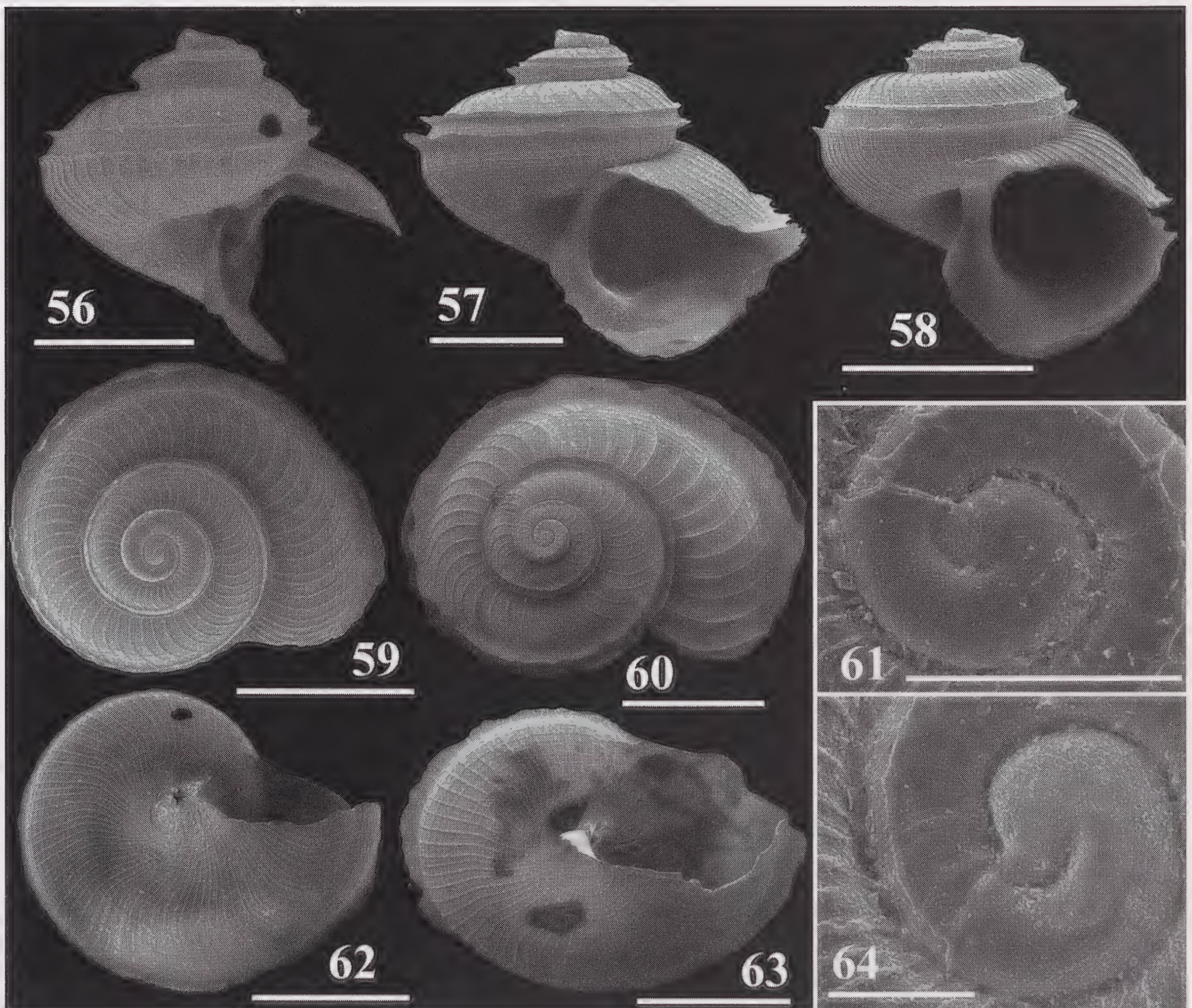
Thielella amoena: Bandel, 1998: 35, pl. 11, figs. 7–8; pl. 12, fig. 1; Geiger, 2003: 74.

Type Locality

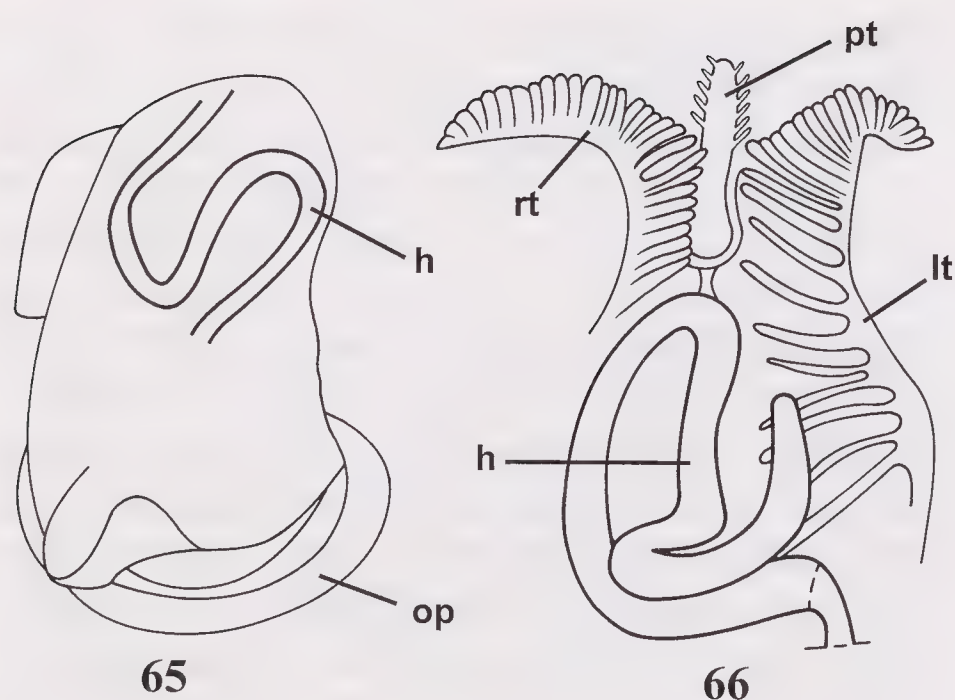
Gauss Station [Davis Sea], Antarctica [66°S, 89°E] (OD).

Material Examined

Lectotype (ZMB-Moll 63047-a) (here designated) and 2 paralectotypes (ZMB-Moll 63047-b). Weddell Sea: 62°46.73'S, 53°02.57'W, 1579–1584 m (16 sps & 4 shs, ZSM Mol 20062197). Ross Sea: 72°05'S, 172°15'E, 392 m (8 shs, USNM 1084418); 72°05'S, 172°15'E, 392 m (4 shs, USNM 1084418); 72°60'S, 172°28'E, 530–548 m (2 shs, NMNZ M.242840). East Antarctica: Lazarev Sea: 69°43'S, 10°46'E, 432 m (11 shs, SMNH 83287); 69°59'S, 08°00'E, 161–185 m (6 shs, SMNH 83288; 7 shs, SMNH 83289; 1 sh, 83290); 69°57'S, 06°20'E, 280–298 m (5 sps, SMNH 83291).



FIGS. 56–64. *Thielella amoena*. FIG. 56: Lectotype; FIGS. 57, 60, 63: Specimen from 62°46.73'S, 53°02.57'W, Weddell Sea, 1579–1584 m (ZSM Mol 20062197); FIGS. 58, 61: Specimen from 72°05'S, 172°15'E, Ross Sea, 392 m (USNM 613010); FIGS. 59, 62, 64: Specimen from 72°60'S, 172°28'E, Ross Sea, 530–548 m (NMNZ M.242840); FIGS. 56–58: Apertural view; FIGS. 59–60: Apical view; FIGS. 61, 64: Protoconch; FIGS. 62–63: Umbilical view. Scale bars FIGS. 56–60, 62–63 = 1 mm; FIG. 61 = 200 μ m, FIG. 64 = 100 μ m.



FIGS. 65–66. *Thieleella amoena*. Anatomy. FIG. 65: Detail of hindgut; FIG. 66: Detail of the pallial cavity roof (inner view). h: hindgut; lt: left tentacle; op: operculum; pt: pallial tentacle; rt: right tentacle. Scale bars = 1 mm.

Other Literature Records

Weddell Sea (Bandel, 1998); Ross Sea: 72°08'S, 172°10'E, 433 m (Dell, 1990); East Antarctica: Breid Bay: 70°10'S, 24°E, 271–310 m (Numanami & Okutani, 1990); 70°09.1'S, 24°01.9'E, 295–310 m (Numanami, 1996).

Distribution

Circumantarctic. 161–1584 m (living specimens: 280–1584 m) (Fig. 51).

Etymology

Amoena: (L.) adjective for pleasant, delightful.

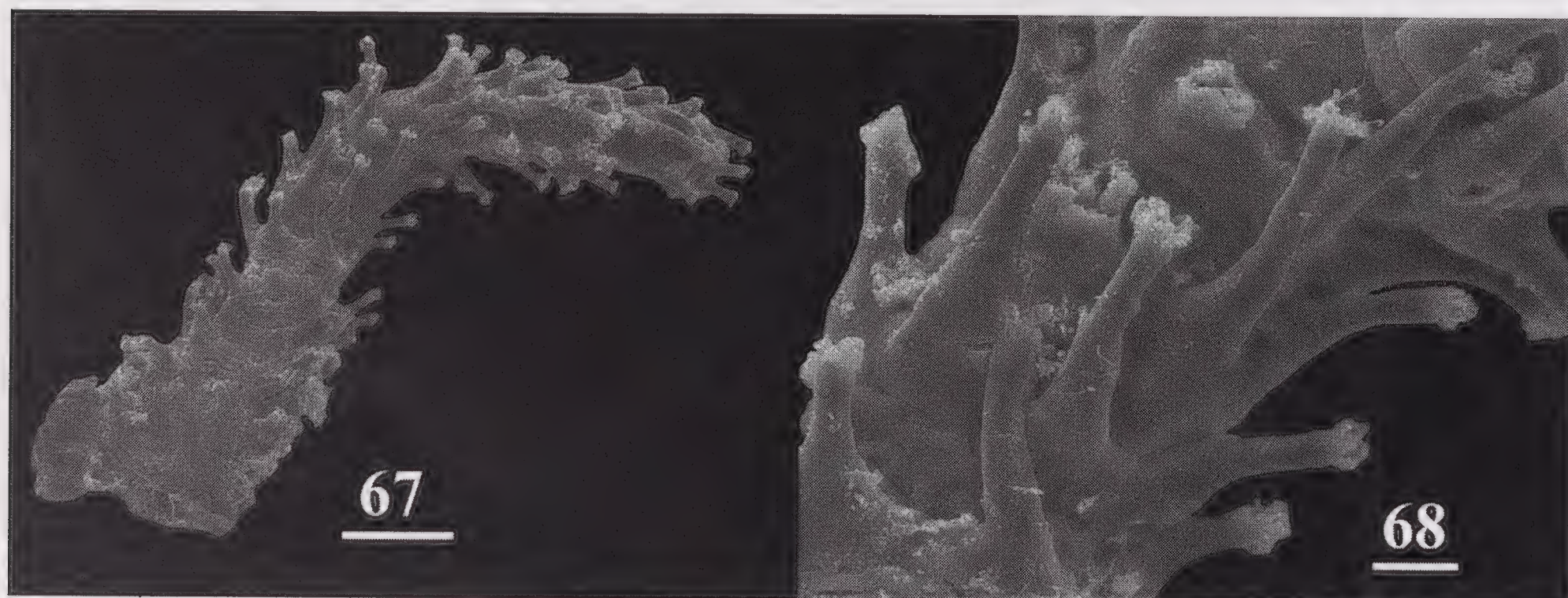
Diagnosis

Shell globose, with reticulate protoconch, strong axial sculpture on teleoconch II, and flared lower portion of aperture.

Description

Shell medium size (up to 3.5 mm in diameter), broad trochiform, broader than high (Figs. 56–58). Protoconch of 3/4 to 1 whorl, 176–196 μ m in diameter, with reticulate sculpture; apertural varix not connected to embryonic cap; apertural margin convex (Figs. 61–64). Teleoconch I of one whorl, with 22–27 axial ribs; spiral cord in position of selenizone forming strong angulation (Figs. 59–60). Teleoconch II with up to 2 1/2 whorls; shoulder with 37–39 axial ribs on first whorl, 38–47 cords on second whorl (Figs. 59–60). Base with spirals somewhat stronger than on shoulder, but weaker than axial ribs (Figs. 62–63). Selenizone at periphery of shell, with elevated keels; slit open, with parallel margins. Umbilicus open (Figs. 62–63).

Head-Foot: Whitish, uniform. Cephalic tentacles long, circular, and papillate. Eyes, eye-stalks absent. Neck wide, with two smooth tentacles on each side. Three pairs of long, sparsely micropapillate epipodial tentacles, present; first epipodial tentacle bifurcated at base with one additional short posterior pteriform appendix (epipodial sense organ?); second and third tentacles simple. Papillae tubular, about 27 to 33 μ m in length, spirally



FIGS. 67–68. *Thieleella amoena*. Details of epipodial tentacles and papillae. Scale bars FIG. 67 = 50 μ m; FIG. 68 = 10 μ m.

arranged, with distal cillia (Figs. 67–68). Pallial cavity with two large bipectinate ctenidia, left one of about 10% larger (Fig. 66). A relatively long, papillate, conical tentacle extending anteriorly, starting in posterior part of mantle sinus (Fig. 66). Hindgut forming inclined “S” (Fig. 65).

Radula (Figs. 69–70): Rachidian tooth trapezoidal at base, with nearly straight cups, showing main central denticle, 5 narrower denticles on each side. Five pairs of lateral teeth; laterals 13 similar in outline, overlapping at their bases; cusps elongate, tongue-like, with one prominent main denticle, 4–6 denticles on outer margin, 3–4 narrower denticles on inner margin; fourth lateral tooth narrower than laterals 1–3, with more delicate serration at cusp; lateral tooth fifth wide at base, with prominent main denticle and strongly serrated margins in cusp. Marginal teeth long, narrow, main denticle straight sharp, numerous serrations on both sides.

Remarks

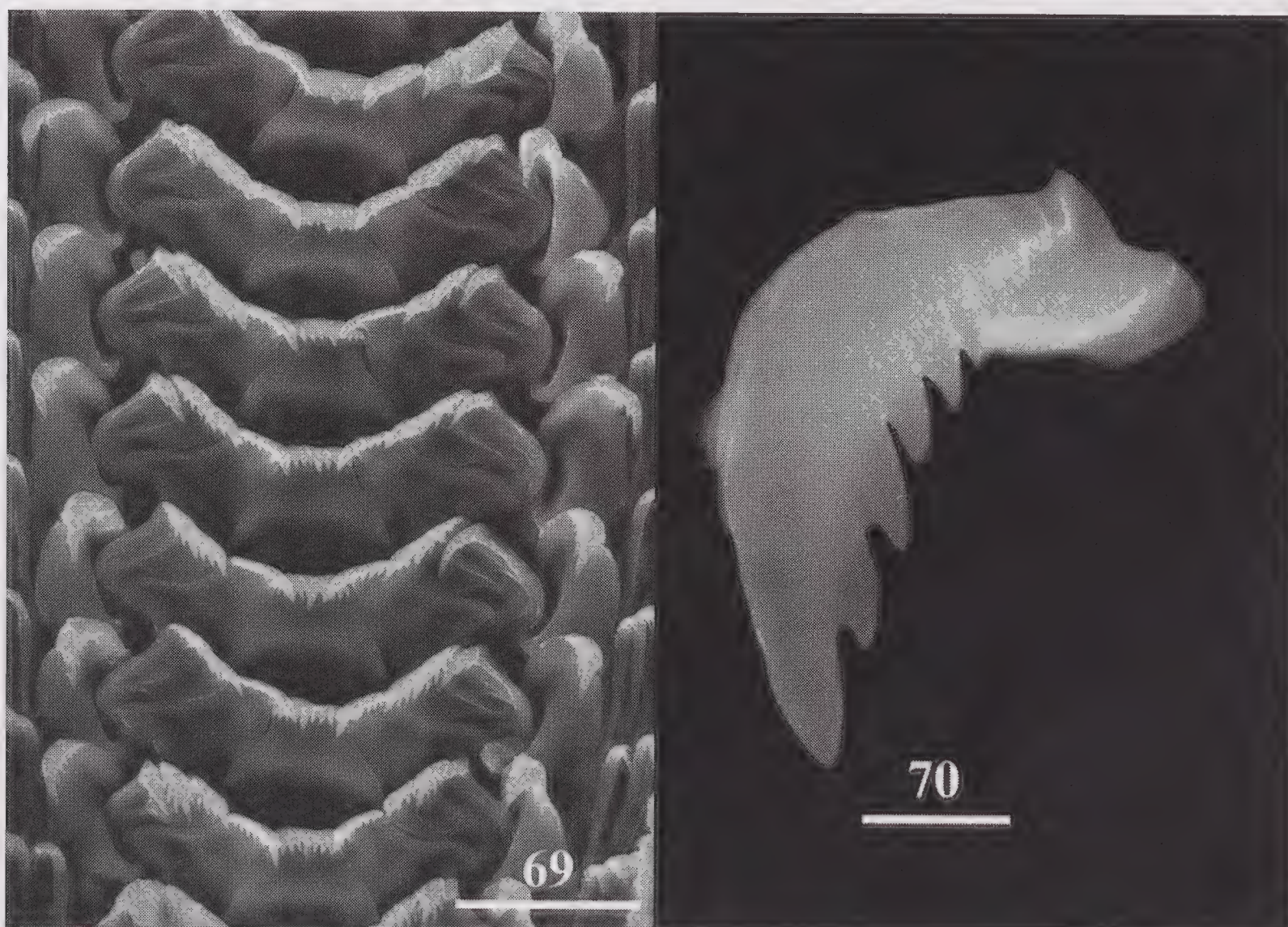
Because *Thieleella amoena* is the type species of the genus, we select here one of the three syntypes as lectotype (Fig. 56) with the

express taxonomic purpose to fix the species concept.

The most similar species to *Thieleella amoena* is *Anatoma conica*. They share the overall globose shell, sculptured with strong axial ribs. However, *T. amoena* has fewer and comparatively narrower axial ribs, a wider selenizone, and an inclined protoconch in apertural view, with flocculant sculpture. In addition, *T. amoena* lacks the flared lower portion of the apertural lip. Furthermore, the two species seem to be allopatric: *A. conica* occurs in the Magellan Region, whereas *T. amoena* occurs in Antarctic waters.

Thieleella gunteri (Cotton & Godfrey, 1933) from eastern Australia has noticeably stronger sculpture on the shoulder compared to the base, more numerous and fainter spirals, and lacks the flared aperture.

Anatoma shiraseae from Antarctica has a distinct keel on the shoulder, a distinct constriction below the selenizone, and a protoconch with flocculant sculpture. The other Antarctic anatomid species, *Anatoma euglypta*, has a biconical shell that is not turreted, a hardly sunken suture, an extremely fine and dense axial and even finer spiral sculpture, and a protoconch with flocculant sculpture.



FIGS. 69–70. *Thieleella amoena*. Radula of a specimen from 62°46.73'S, 53°02.57'W, 1579–1584 m (ZSM Mol 20062197). FIG. 69: General view; FIG. 70: Detail of lateral tooth 5. Scale bars FIG. 69 = 20 μ m; FIG. 70 = 2 μ m.

Thieleella weddelliana n. sp.

Figures 51, 71–84

Type Locality

70°31.08'S, 14°34.83'W, Weddell Sea, 4384–4420 m.

Type Material

Holotype (ZSM Mol 20062198) and 2 paratypes (ZSM Mol 20062199).

Distribution

Known only from the type locality (Fig. 51).

Etymology

The species is named after the type locality.

Diagnosis

Thieleella weddelliana is characterized by having a large, laterally expanded shell, with rounded whorls, wide and deep umbilicus, and strong axial ribs.

Description

Shell large (up to 5.6 mm in diameter), trochiform, laterally expanded (Fig. 71). Protoconch of one whorl, about 220 µm in diameter, with reticulate ornamentation; margin of protoconch convex, without varix (Fig. 74). Teleoconch I of 3/4 to 5/6 rounded whorls, sculptured with 10–12 axial ribs, one spiral cord in position of selenizone forming strong angulation; teleconch II of up to 2 3/4 whorls (Fig. 73). Whorls of spire rounded; last whorl nearly straight; shoulder and base convex. Shell with cancellate sculpture; axial ribs strong: 22–26 on shoulder of first whorl, 27–28 on second whorl, 31–41 on base; spiral threads weak, beginning at start of selenizone, gradually increasing in number with growth: 5–8 on first whorl, 25–30 at apertural margin (Figs. 71–73). Selenizone displaced towards suture, sculptured with low axial ribs, surrounded by narrow, strong keels (Fig. 71). Umbilicus open, wide, deep (Fig. 72); funiculus present. Aperture rounded.

Anatomy: Animal pale cream, uniform. Cephalic tentacles long, lanceolate, flat,

sparsely papillate; papillae tubular, of about 110 µm long, spirally arranged, slightly expanded distally with a half full of cilia (Figs. 80, 83–84). Eyes and eyestalks absent. Head separated from foot by wide neck, with one pair of smooth cylindrical tentacles on each side. Three pairs of conical papillate epipodial tentacles; first epipodial tentacle divided basally forming two tentacles. Papillae similar to that of cephalic tentacles, but smaller (42–50 µm long) (Figs. 81–82). Columellar muscle thick, elongate in outline. Pallial cavity with enlarged mantle border, deeply sinuated in medial line, one rounded papillate tentacle extending anteriorly in medial line (Fig. 78). Two large bipectinate ctenidia; left ctenidium about 10% larger than right. Hindgut very large, sinuous, drawing posteriorly directed loop at left side, before ending in anus (Figs. 78–79).

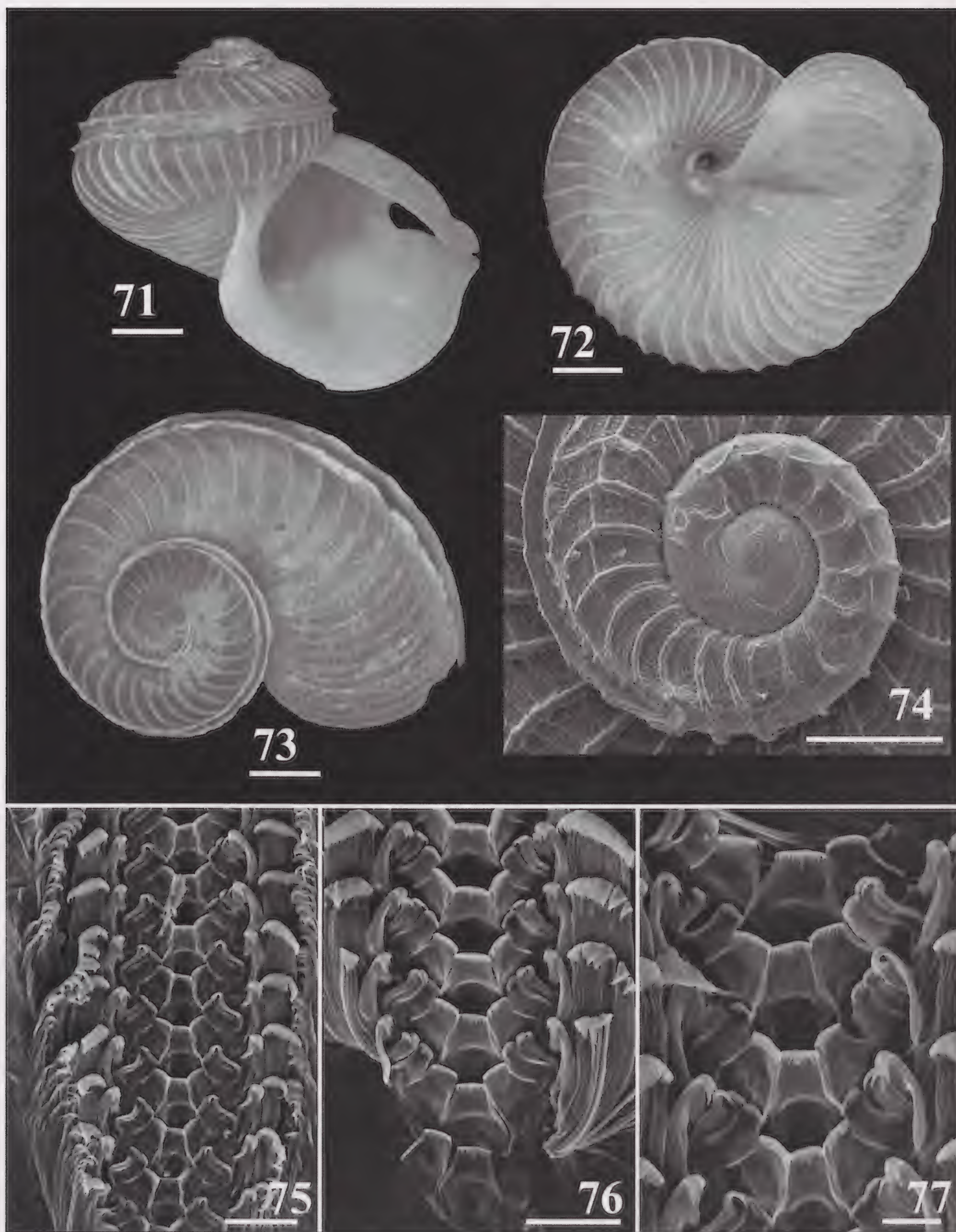
Radula (Figs. 75–77): Rachidian tooth trapezoidal at base, cusp nearly straight, with one main central denticle and 6–10 narrower, sharper denticles on each side. Five pairs of lateral teeth; laterals 1–3 with rectangular bases, innermost tooth widest; cusp with prominent innermost denticle, 7–11 narrower denticles on outer margin; inner margin smooth. Fourth lateral tooth narrower than lateral 3; lateral tooth 5 claw-shaped, wider at base, with wide, sharply serrated cusp. Marginal teeth numerous, long, narrow, becoming more delicate outwards, with prominent, delicately serrated cusp.

Remarks

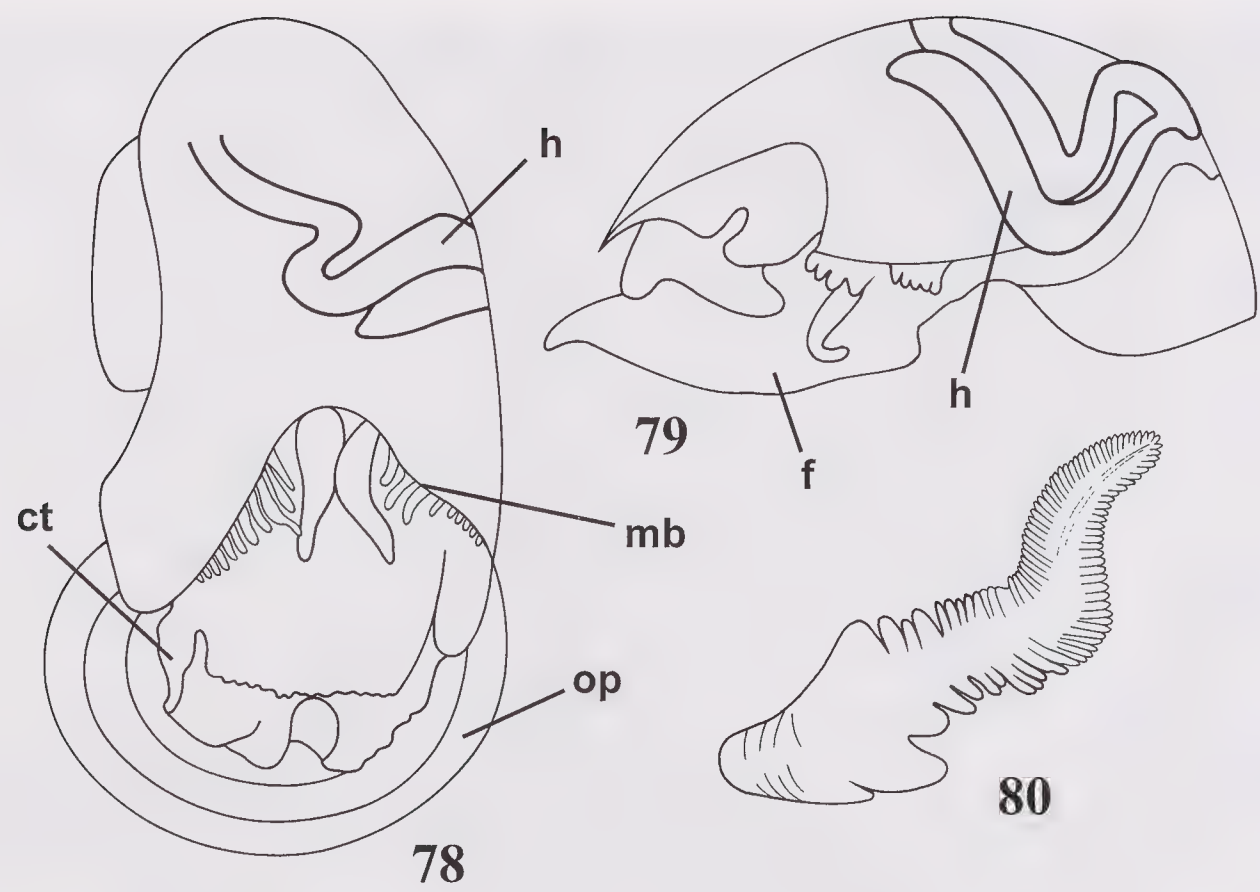
Thieleella weddelliana resembles *Thieleella amoena* and *Anatoma conica*, from which it differs in having a larger shell, with wider umbilicus and selenizone displaced towards the suture. Furthermore, the last whorl is more uniformly rounded in *A. conica* and *T. amoena* than in ***T. weddelliana***. In addition, ***T. weddelliana*** has fewer axial ribs in the first whorl of teleoconch II than *T. amoena* (22–26 vs. 37–39).

Thieleella weddelliana differs from *Anatoma euglypta* and *Anatoma shiraseae*, the other two Antarctic species of anatomids, in having a globular instead of a biconical last whorl, and stronger axial sculpture.

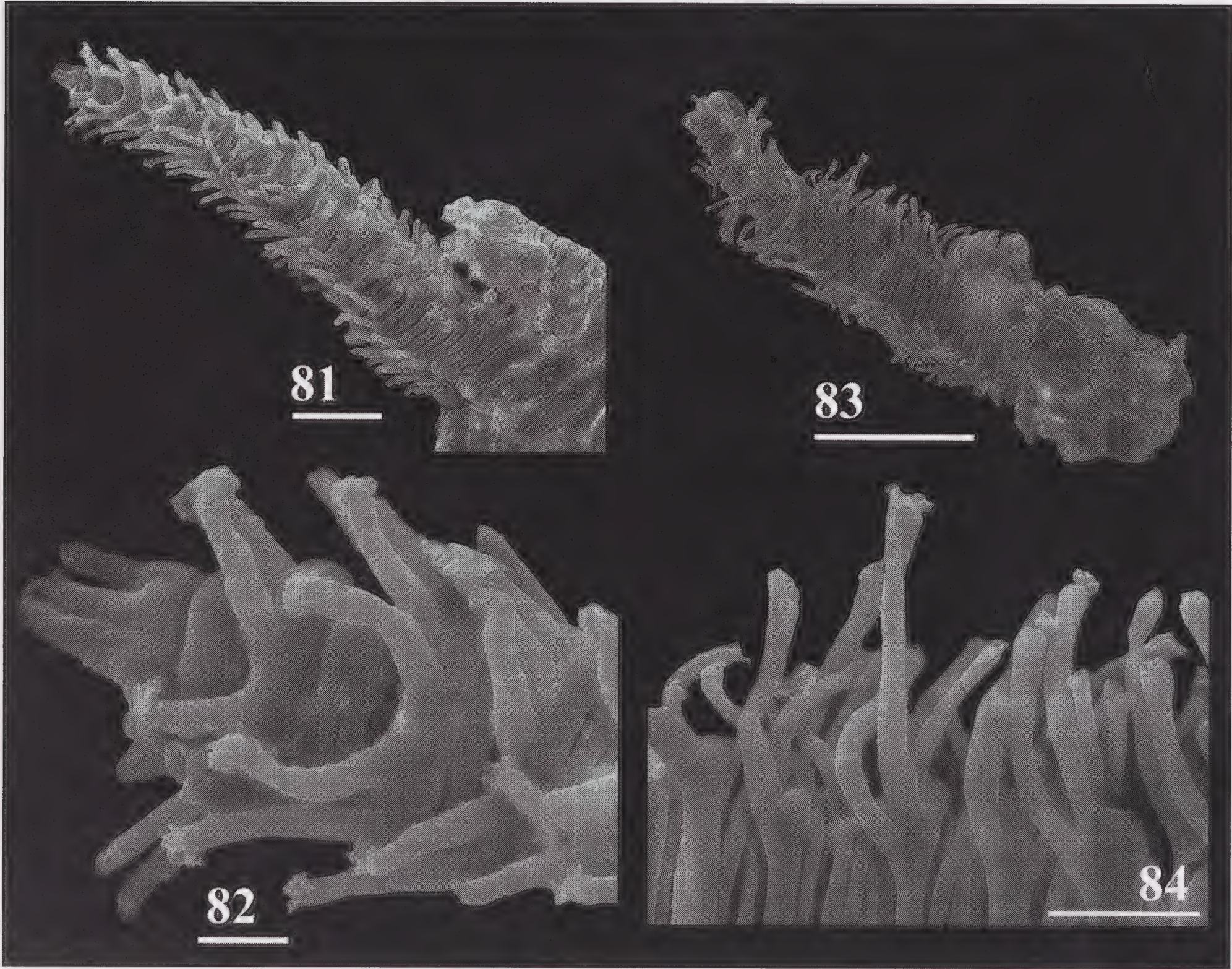
Thieleella baxteri (McLean, 1984) from the northeastern Pacific is similar in overall shape,



FIGS. 71–77. *Thieleella weddelliana*. FIGS. 71–73: Holotype (ZSM Mol 20062198); FIGS. 74–77: Paratypes; FIG. 71: Apertural view; FIG. 72: Umbilical view; FIG. 73: Apical view; FIG. 74: Protoconch; FIGS. 75–77: Radula. Scale bars FIGS. 71–73 = 1 mm; FIG. 74 = 200 µm; FIGS. 75–76 = 50 µm; FIG. 77 = 20 µm.



FIGS. 78–80. *Thieleella weddelliana*. Anatomy. FIGS. 78–79: Detail of hindgut (h); FIG. 78: Frontal view; FIG. 79: Lateral view; FIG. 80: Detail of cephalic tentacle. ct: cephalic tentacle; f: foot; mb: mantle border; op: operculum.



FIGS. 81–84. *Thieleella weddelliana*. FIGS. 81–82: Epipodial tentacle; FIG. 81: General view; FIG. 82: Detail of papillae; FIGS. 83–84: Cephalic tentacle; FIG. 83: General view; FIG. 84: Detail of papillae. Scale bars FIG. 81 = 100 μ m; FIG. 82 = 20 μ m; FIG. 83 = 250 μ m; FIG. 84 = 50 μ m.

but has more numerous (30 vs. 13) weaker axial ribs on teleoconch I, and lacks a spiral cord in the position of the selenizone on teleoconch I. The differences in the density and strength of the sculpture are similar on teleoconch II. As the spiral threads on shoulder and base are of equal strength in both species, *T. baxteri* appears more reticulate as spirals and axials are more equal in strength, whereas in *T. weddelliana*, the axial ribs are much more prominent than the spirals.

The reticulate protoconch sculpture of this species is composed of smaller and more irregular cells than in other *Thieleella* species. The observed sculpture is best described as reticulate, which is diagnostic for *Thieleella*. The sculpture of *T. weddelliana* cannot be described as the flocculent type frequently encountered in *Anatoma* spp. As discussed elsewhere (Geiger, 2003), the single character is provisionally considered sufficient to diagnose the genus, though confirmation through other lines of evidence is desirable.

***Thieleella argentinae* n. sp.**

Figures 51, 85–89

Type Locality

43°33'S, 48°58.1'W, Argentine Basin, 5208–5223 m, stn 247, Atlantis II-60 Expedition.

Type Material

Holotype (MCZ 356975, operculum and radula on SEM stub, shell); 15 paratypes from type locality (MCZ 345737; broken shells with fluid preserved animals); 3 paratypes (MCZ 345380; small shells with fluid preserved animals), 36°55.7'S, 53°01.4'W, Argentine Basin, 2707 m, stn 245, Atlantis II-60 Expedition.

Distribution

36°55.7'–43°33'S, 53°01.4'–48°58.1'W, Argentine Basin, 2707–5223 m (Fig. 51).

Etymology

Named for its provenance.

Diagnosis

A depressed and widely umbilicated *Thieleella*, with a large protoconch of about 480 µm in diameter, and cancellate shell sculpture.

Description

Shell large (up to ~ 5 mm in diameter), trochiform, broader than high (Fig. 85). Protoconch of one whorl, globose, about 480 µm in diameter, with reticulate sculpture; apertural margin convex, with prominent varix (Fig. 86). Teleoconch I of 5/8 whorls, sculptured with 11 axial ribs; spiral cord in position of selenizone forming angulation (Fig. 88). Teleoconch II of 1 1/4 whorls at 1.3 mm (broken in the aperture); shoulder with 57 axial ribs in the first whorl, and narrower spiral threads than increase in number and solidness with growth. Base with prominent spirals surrounding umbilicus. Umbilicus open, wide (Fig. 87). Selenizone at periphery, with elevated keels; condition of slit unknown. Operculum corneous, multispiral, slightly smaller than aperture (Fig. 89).

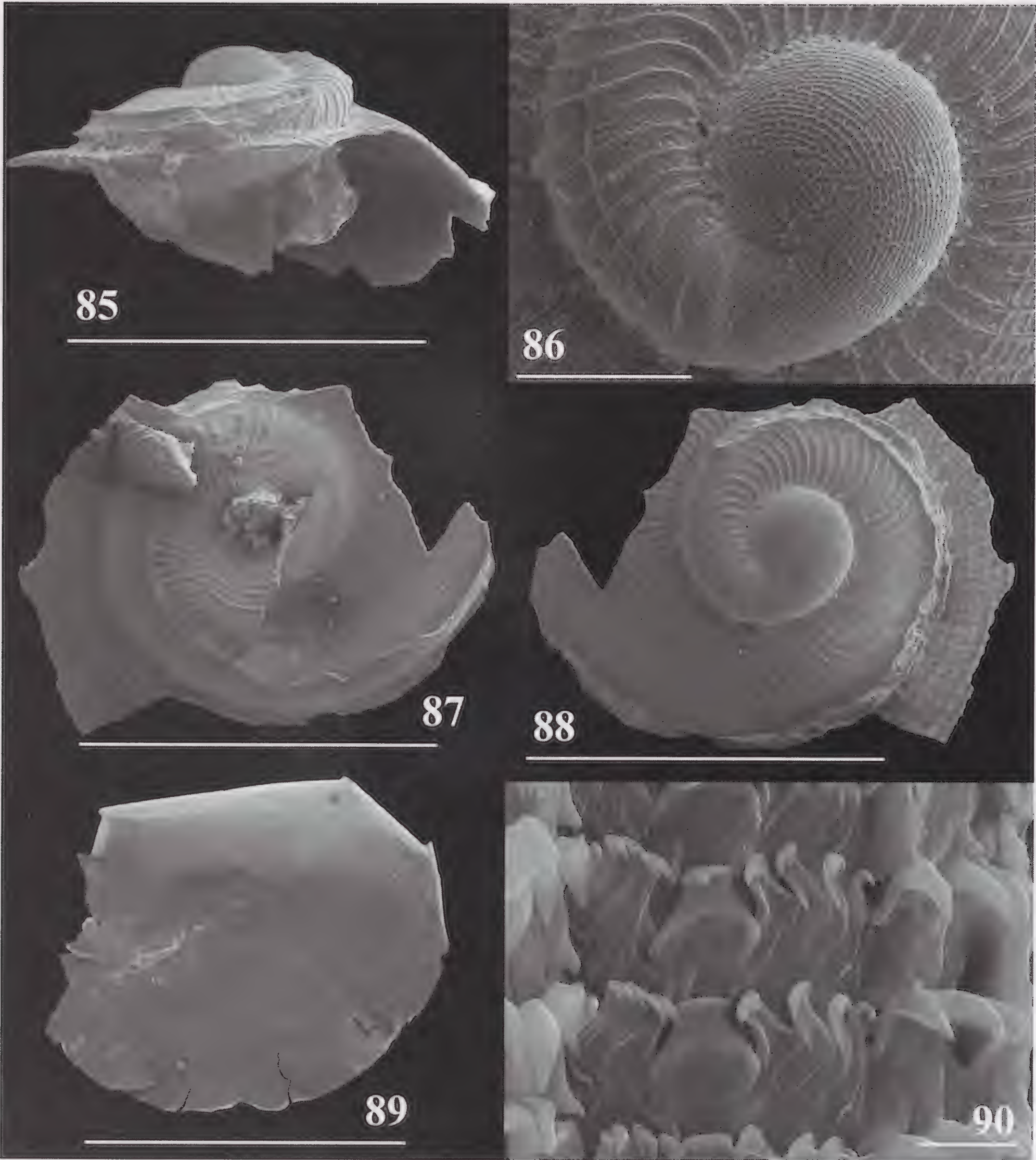
Anatomy: Cephalic tentacles long, papillate; eye and eyestalks absent; two neck tentacles, present; first epipodial tentacle with three branches, second with two.

Radula (Fig. 90): Rachidian tooth pyriform at base; cutting edge straight, with one main central denticle and 4–5 smaller, sharper denticles on each side. Five pairs of lateral teeth; laterals 1–3 relatively wide at bases, with triangular cusps, bearing one main apical denticle and 3–4 narrower denticles on outer margin; fourth lateral tooth narrower and smaller; lateral tooth 5 strong, with wide base, sharply serrated inner margin of cusp. Marginal teeth numerous; inner marginals similar to lateral tooth 5; outer marginals more delicate with finely denticulated cusps.

Remarks

Thieleella argentinae is most similar to *Anatoma josephinae* Odhner, 1960, described from the Sargasso Sea (28°N), 6000 m depth. However, *T. argentinae* has a somewhat larger protoconch (480 µm vs. 357 µm) with reticulate sculpture, which is inflated in the region of the embryonic cap, while in *A. josephinae* the protoconch shows the typical spiral coiling. In addition *T. argentinae* has a teleoconch I of 1 1/4 whorls, sculptured with 11 axial ribs, while *A. josephinae* has 3/5 whorls and 18 axials ribs.

The available specimens of *Thieleella argentinae* have only the early portion of the teleoconch I along with the protoconch preserved. Although the specimens are very incomplete, they clearly belong to a new species.



FIGS. 85–90. *Thielella argentineae*. Holotype (MCZ 356975). FIG. 85: Apertural view; FIG. 86: Protoconch; FIG. 87: Umbilical view; FIG. 88: Apical view; FIG. 89: Operculum; FIG. 90: Radula. Scale bars FIGS. 85, 87–89 = 1 mm; FIG. 86 = 200 μ m; FIG. 90 = 20 μ m.

Scissurellidae Gray, 1847

Diagnosis

Shell 0.6–3 mm, trochoid, more or less depressed; protoconch sculpture variable; slit above periphery, open (*Scissurella*, *Incisura*), closed (*Ariella*, *Sinezona*, *Satondella*, *Incisura*), or absent (*Coronadoa*); radula with lateral tooth 5 enlarged by broadening.

Remarks

Anatomidae have the slit or foramen at the periphery and lateral tooth 5 is enlarged by elongation. More comprehensive diagnoses

and discussions have been provided elsewhere (Geiger, 2003, 2006a, b; Geiger & Jansen, 2004a, 2004b).

Scissurella d'Orbigny, 1824

Type Species (SD: Gray, 1847): *Scissurella laevigata* d'Orbigny, 1824.

Diagnosis

Shell 0.6–2 mm, trochiform depressed, many protoconch ornamentations except reticulate and microhexagonal; slit above periphery, open. More comprehensive diagnoses and discussions have been provided elsewhere (Geiger, 2003; 2006a, b; Geiger & Jansen, 2004b).

Scissurella clathrata Strebel, 1908
Figures 91–120

Scissurella clathrata Strebel, 1908: 77–78, pl. 6, fig. 84a–d; Thiele, 1912b: 9, pl. 1, figs. 18–19; Powell, 1960: 126; Ageitos de Castellanos

& Landoni, 1988: 7, pl. 1, fig. 3; Linse, 1997: 27; Linse & Brandt, 1998: 883; Linse, 1999: 400.

Scissurella eucharista Melvill & Standen, 1912: 344, pl., fig. 1–1a; Powell, 1960: 126; Ageitos de Castellanos & Landoni, 1988: 6, pl. 1 fig. 2.

Schizotrochus clathrata [sic]: Carcelles & Williamson, 1951: 251.

Schizotrochus eucharista [sic]: Carcelles & Williamson, 1951: 251.

Anatoma clathrata: Lozouet, 1986: 112; Linse, 2002: 64–67 [in part], fig. 4.2–2, pl. 1b, figs. 9.1.1.5–9.1.1.8.

Scissurella/Anatoma? clathrata: Geiger, 2003: 76.

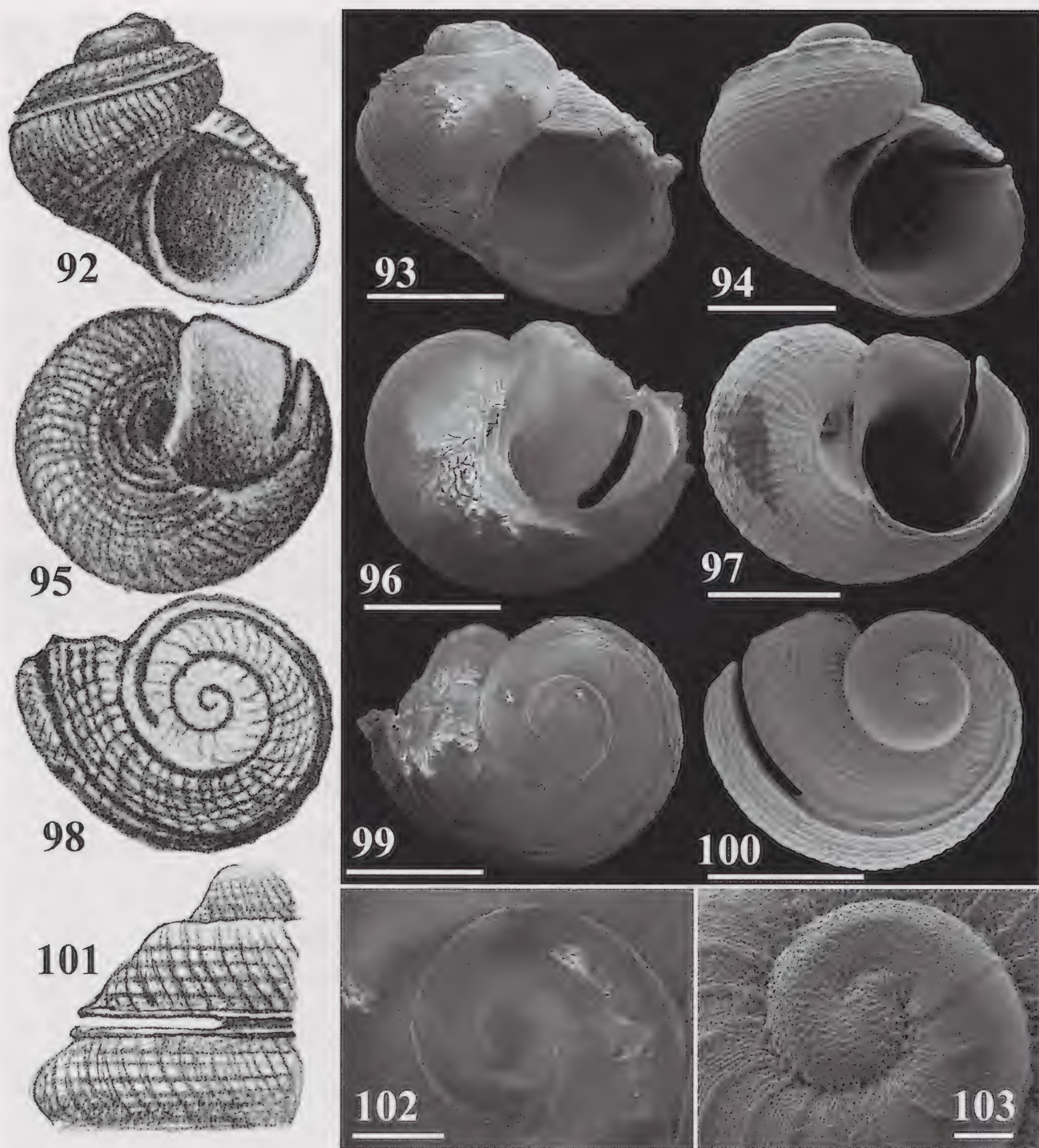
Scissurella obliqua Watson: Geiger, 2003: fig. 16e [non Watson, 1886].

Type Localities

54°43'S, 64°08'W, Feuerland [= Tierra del Fuego, Argentina], 36 m (*Scissurella clathrata*) (OD). 54°25'S, 57°32'W, Burdwood Bank, 56 ft [102 m] (*Scissurella eucharista*) (OD).



FIG. 91. Distribution of *Scissurella clathrata*. ●: material examined; ○: bibliographic records.

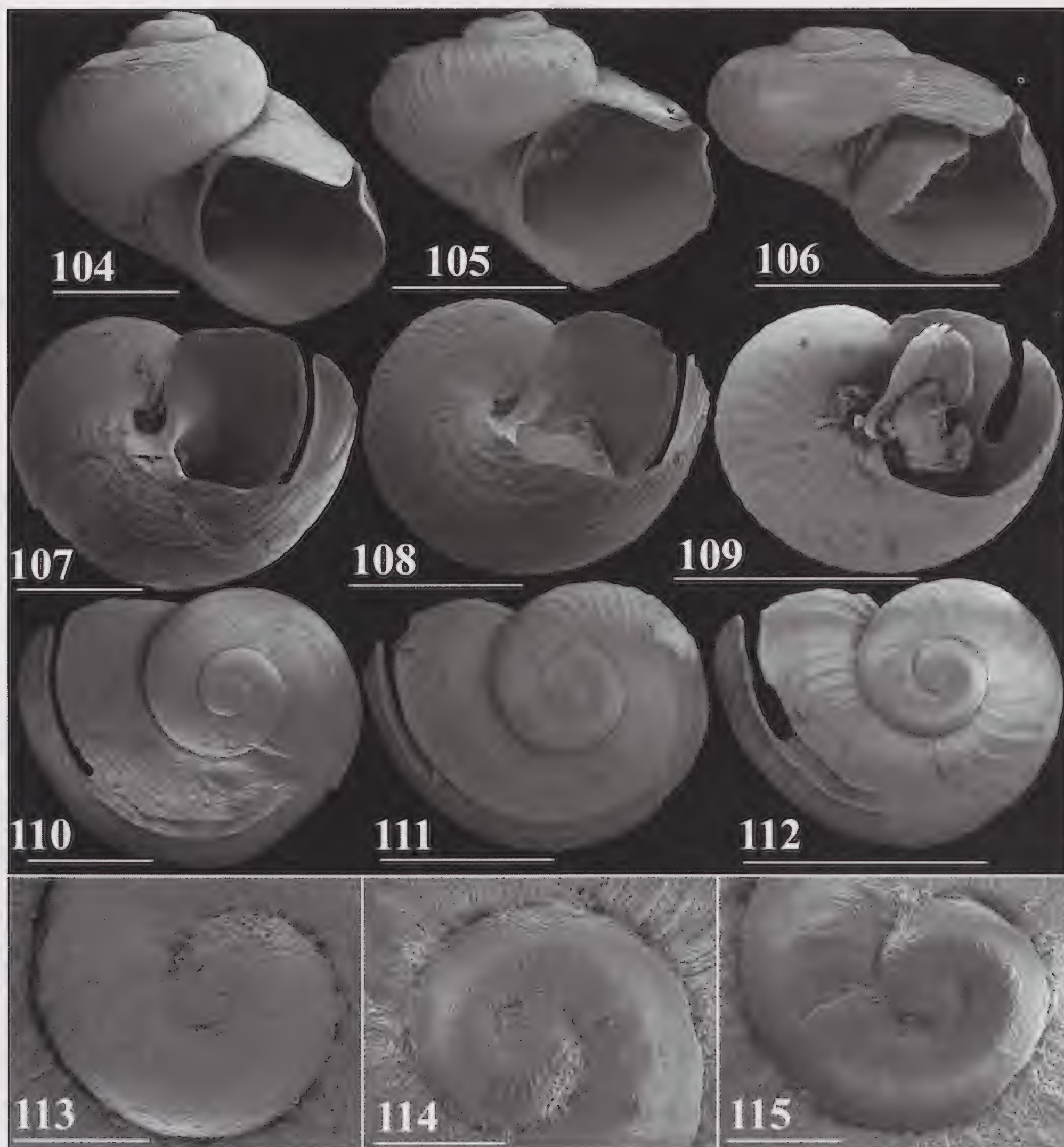


FIGS. 92–103. *Scissurella clathrata*. FIGS. 92, 95, 98, 101: Original figures of *Scissurella clathrata* by Strebel (1908); FIGS. 93, 96, 99, 102: Holotype of *Scissurella eucharista* (NMSZ 1921.143.595); FIGS. 94, 97, 100, 103: Specimen from 55°03'S, 66°37'W, 30–35 m (MLP 12079); FIGS. 92–94: Apertural view; FIGS. 95–97: Umbilical view; FIGS. 98–100: Apical view; FIG. 101: Detail of selenizone and shell sculpture; FIGS. 102–103: Protoconch. Scale bars FIGS. 93–94, 96–97, 99–100 = 500 µm; FIG. 102 = 100 µm; FIG. 103 = 50 µm.

Material Examined

Holotype of *Scissurella eucharista* (NMSZ 1921.143.595). Southern Argentina: 54°48'S, 65°16'W, W side of Bahía Buen Suceso, 0 m (8 sps & 3 shs, LACM 71-270); Isla de los Estados: 54°43'S, 64°14'W, Isla Conett, 17 m

(1 sh, LACM 73-66); 54°34'S, 64°10'W, Isla Observatorio, 73 m (4 shs, LACM 71-316); 54°34'S, 64°30'W, Cabo San Antonio, 73–76 m (16 shs, LACM 71-352). Beagle Channel: 55°07'18"S, 66°52'47"W, Punta Rico, 25 m (26 sps & 10 shs, ZMH 19589); 55°38'31"S, 67°12'52"W, Isla Wollaston, 40 m (39 sps &



FIGS. 104–115. *Scissurella clathrata*. Ontogenetical variability. FIGS. 92, 104, 107, 110, 113: Specimen from 43°14'S, 73°36'W, E side Isla Laitec, 3–6 m (LACM 75-46); FIGS. 105, 108, 111, 114: Specimen from 43°54'S, 73°43'W, Westhoff Island, 22 m (LACM 73-75); FIGS. 106, 109, 112, 115: Specimen from 45°27'S, 74°24'W, Canal Darwin, 9 m (LACM 73-74); FIGS. 104–106: Apertural view; FIGS. 107–109: Umbilical view; FIGS. 110–112: Apical view; FIGS. 113–115: Protoconch. Scale bars FIGS. 104–112 = 500 μ m; FIGS. 113–115 = 100 μ m.

127 shs, ZMH 19591). 55°00'31''S, 66°53'08''W, Isla Gardiner, 103 m (1 sp, ZMH 19594); 54°52'S, 68°13'W, 12–20 m (1 sh, MLP 12068); 54°50'S, 68°15'W, 18–21 m (1 sp, MLP 12069); 54°50'S, 68°20'W, 5 m (4 shs, MLP 12070); 54°50'S, 68°19'W, 5 m (2 shs, MLP 12071); 54°52'S, 68°14'W, 7–13 m (3

sps, MLP 12072); 54°51'S, 68°19'W, 5–10 m (1 sh, MLP 12073); 54°52'S, 68°07'W, 21–23 m (1 sp, MLP 12074); 54°51'S, 68°02'W, 27 m (2 sps, MLP 12075); 54°55'S, 67°21'W, 15–20 m (6 sps & 6 shs, MLP 12076); 54°57'S, 67°01'W, 30–40 m (15 sps, MLP 12077); 55°02'S, 66°42'W, 1520 m (2 sps & 1 sh, MLP

12078); 55°03'S, 66°37'W, 30–35 m (22 sps. and 28 shs MLP 12079); 55°06'S, 66°29'W, 65–80 m (6 sps & 3 shs, MLP 12080); 55°06'50"S, 66°55'32"W, Isla Picton, 110 m (1 sp, ZMH 19590); SE of Isla Picton: 55°06'53"S, 66°39'57"W, 63 m (218 sps & 204 shs, ZMH 19592); 55°07'36"S, 66°44'36"W, 33 m (3 sps, ZMH 19593). Magellan Strait: 52°57'30"S, 70°41'00"W, Bahía Laredo, 90 m (1 sp, ZMH 19587); 54°22'S, 71°21'W Punta Valparaíso, Canal Cockburn, 18 m (13 shs, LACM 73-69); 52°24'S, 73°39'W, Punta Dashwood, Canal Smyth, 13 m (11 shs, LACM 73-71); Península Brunswick: 53°37'S, 70°56'W, Puerto Hambre, S of Punta Askew, 0 m (3 shs, LACM 75-49); 53°38'S, 70°54'W, Punta Santa Ana, Fuerte Bulnes, 0 m (2 shs, LACM 75-45). Southern Chile: 43°54'S, 73°43'W, Westhoff Island, 22 m (40 shs, LACM 73-75); 46°35'S, 75°30'W, Bahía San Andres, N of Golfo de Peñas, 1 m (13 shs, LACM 73-73); 43°14'S, 73°36'W, E side of Isla Laitec, Chiloé Island, 3–6 m (20 shs, LACM 75-46); 42°38'S, 72°57'W, Islota Nihuel, Golfo Corcovado, Chiloé Province, 3–15 m (4 shs, LACM 75-43); 45°27'S, 74°24'W, Canal Darwin, 9 m (29 shs, LACM 73-74); 50°11'S, 74°48'W, Bahía Tom, 15 m (80 sps, LACM 73-72); 52°56'S, 75°00'W, 92–101 m (3 shs, NMNZ M.242830); 52°40'S, 74°58'W, 64 m (2 shs, NMNZ M.242829).

Other Literature Records

Beagle Channel: 55°07.3'S, 66°53.0'W, Punta Rico, 25 m (Linse, 2002); 55°07.2'S, 66°40.2'W, SE of Isla Picton, 67 m (Linse, 2002).

Distribution

Magellan Region. 0–110 m (living over entire bathymetric range) (Fig. 91).

Etymologies

Clathrata: (L.) referring to the cancellate sculpture. *Eucharista*: *Eucharistos* (G.) for elegant, agreeable.

Diagnosis

Shell inflated with densely cancellate sculpture.

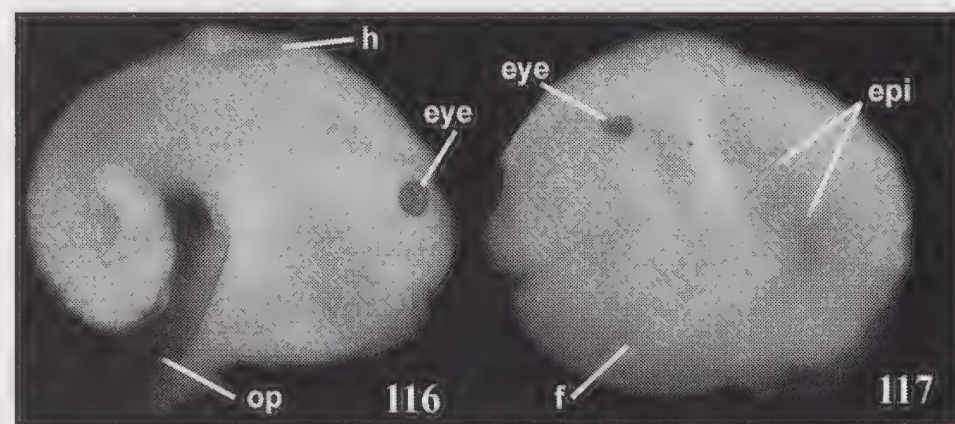
Description

Shell of medium size (up to 1.4 mm in diameter), trochiform, inflated (Figs. 92–94, 104–

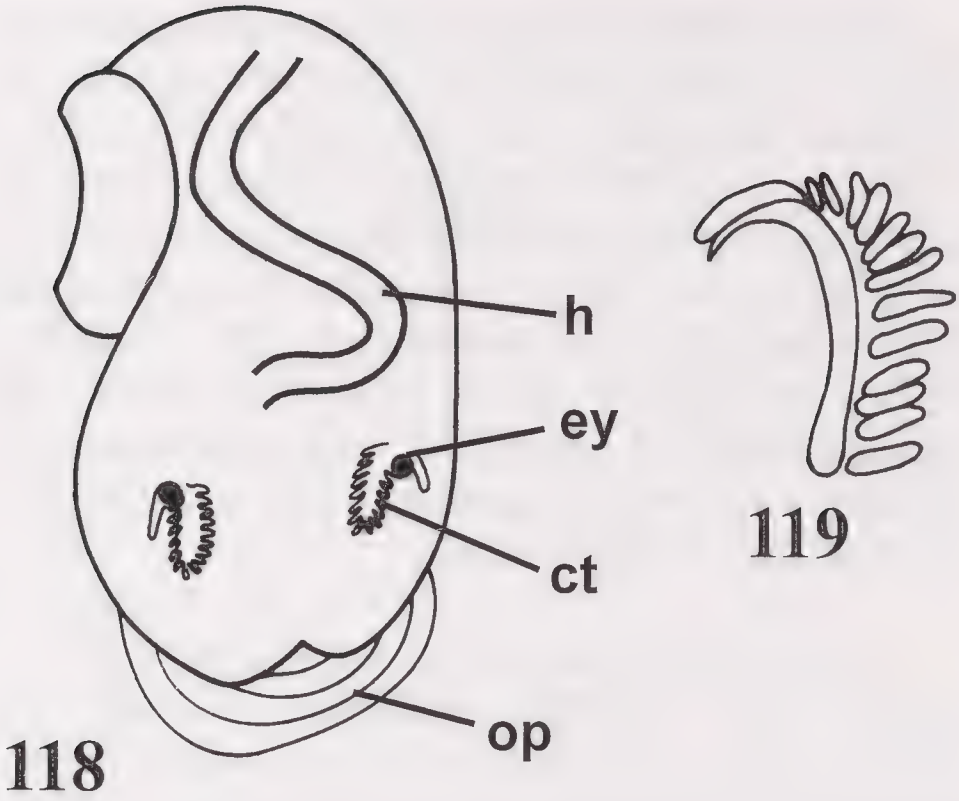
106). Protoconch of 1 to 1 1/8 whorls, 190–250 µm in diameter, with flocculant sculpture; apertural margin convex, without varix (Figs. 102–103, 113–115). Teleoconch I of 7/8–1 whorl, sculptured with 24 delicate spiral cords, 24–39 axial ribs; interstices with irregular growth marks (Figs. 98–100, 110–112). Teleoconch II of up to 1 1/8 whorls, with convex shoulder; juveniles laterally expanded, mature specimens with inflated base (Figs. 104–106); sculpture cancellate, consisting in 37–45 low, irregularly spaced axial ribs, 16–19 spirals cords, forming small nodules at intersections (Figs. 92–101, 104–112). Selenizone above periphery, surrounded by low keels having low growth marks; slit open, with parallel margins (Figs. 92–94, 104–106). Umbilicus moderately narrow, bordered by carina of smooth walls (Figs. 95–97, 107–109). Aperture round, roof overhanging.

Anatomy (Figs. 116–119): Color pale cream, uniform. Pallial cavity with two large bipectinate ctenidia, left one of about 10% larger. Cephalic tentacles short, flat, foliated, papillate. Eyestalks short, fused at base of cephalic tentacles; eyes black, lens half of eye in diameter. Three pairs of conical, relatively long, papillate epipodial tentacles; first epipodial tentacle divided basally forming two tentacles, with posterior branch bifurcated distally; second and third tentacles simple. Foot long, narrow; foot sole completely ciliated. Columellar muscle thick, triangular in outline. Single small tentacle located at postero-dorsal part of mantle cavity. Salivary glands elongate, larger than odontophore. Intestine very long, with hindgut forming wide inverted "S".

Radula (Figs. 120–122): Rachidian tooth with broadly triangular base and nearly straight



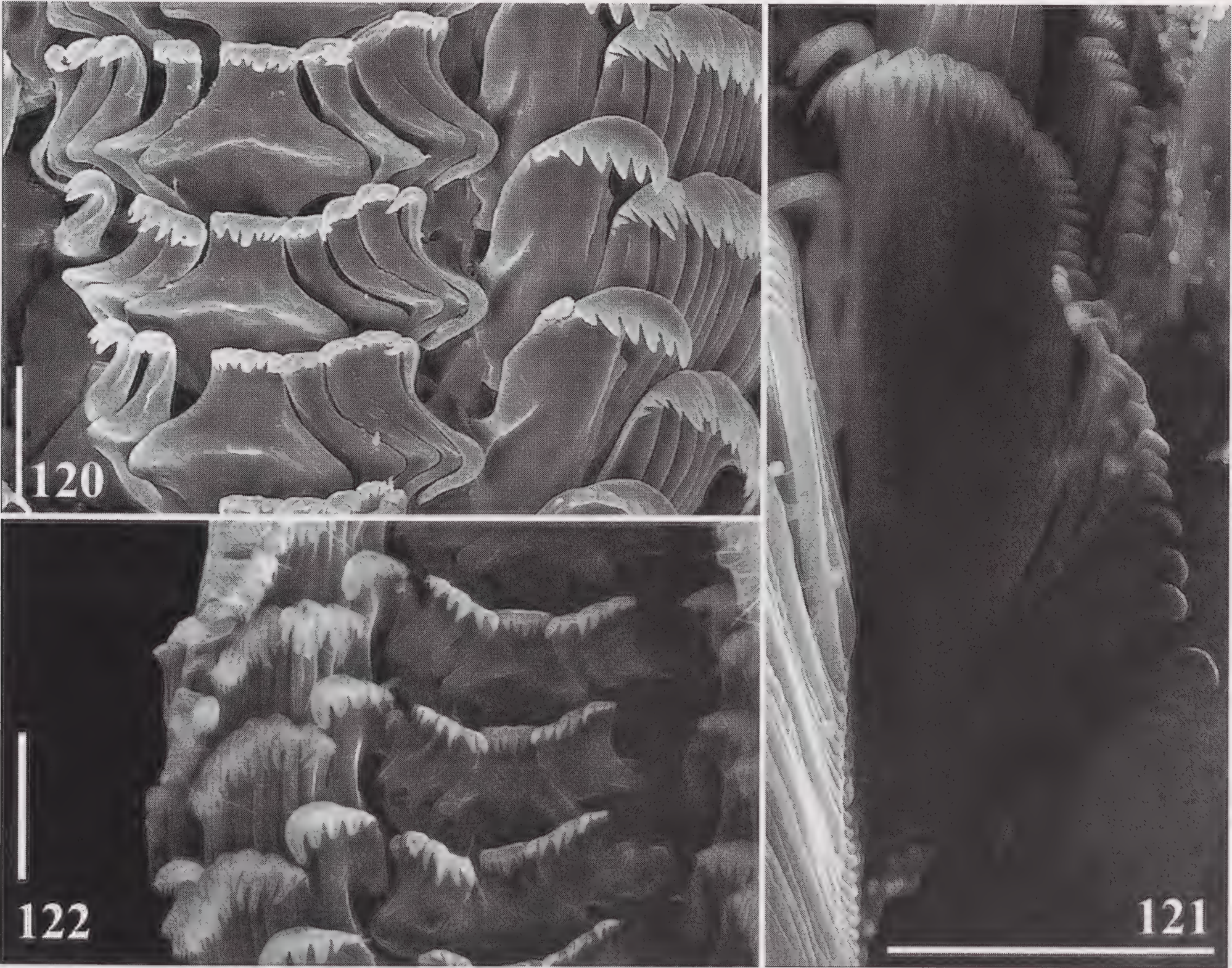
FIGS. 116–117. *Scissurella clathrata*. Anatomy. FIG. 116: Lateral view; FIG. 117: Ventral view. epi: epipodial tentacle; eye: eye; f: foot; h: hindgut; op: operculum.



cusps, with a main central denticle and 3 narrower denticles on each side. Lateral teeth 1–3 similar; cusp with three denticles on outer margin. Lateral tooth 4 reduced, with one central denticle on cusp, and one smaller denticle on each side. Lateral tooth 5 wider, larger than other laterals, with 7 strong, rounded at tip, denticles on inner margin; outer margin smooth. Radular interlock of central field moderate. Inner marginal teeth with main terminal denticle, three denticles on inner margin, four denticles on outer margin; outer marginals spoon shaped.

Remarks

The holotype of *Scissurella clathrata* could not be located at SMNH, although SMNH records place it there (K. Sindemark, 3/2006, pers. comm.), nor at ZSM (Zelaya, 9/2006,



FIGS. 120–122. *Scissurella clathrata*. Radula. FIGS. 120–121: Specimen from 50°11'S, 74°48'W, Bahía Tom, 15 m (LACM 73-72); FIG. 122: Specimen from 55°03'S, 66°37'W, Cabo San Pío 30–35 m (MLP 12079). Scale bars = 10 µm.

pers. obs.), where other material of Strebel is housed. However, the species is clearly recognizable from the original description and figures (Figs. 92, 95, 98, 101).

Linse (2002) described the protoconch of this species as smooth and placed *clathrata* in *Anatoma* on the basis of this character. However, Geiger (2003) showed that protoconch sculpture is very variable and not suitable for generic diagnoses in scissurellids. In addition, Linse's (2002: fig. 9.1.1–7) figure of the protoconch shows evidence of erosion. The examination of numerous additional specimens during this study reveals that the protoconch of this species is not actually smooth but has flocculant sculpture (Figs. 102–103, 113–115).

The radula of the material here studied as well as that illustrated by Linse (2002: pl. 1, fig. 9.1.1–8) shows that the cusp of lateral tooth 5 is serrated only on the inner margin. This radular characteristic clearly indicates that the species belongs to Scissurellidae and not Anatomidae; the open slit places the species in the genus *Scissurella*.

Linse (2002) reported *Scissurella clathrata* from 53°28.8'S, 70°21.9'W, Estrecho, P. Ancho, 92 m. Material from this locality identified as *S. clathrata* by Linse (ZMH 19588) is here re-identified as *Anatoma conica*.

A specimen of *Scissurella clathrata* was found at raised beaches from Río Ovando, Southern Tierra del Fuego. This area was dated in 4,100 years before present, and is located 3 m over the present sea level (Zelaya & Gordillo, unpubl. data).

Scissurella petermannensis Lamy, 1910
Figures 123–146

Scissurella petermannensis Lamy, 1910: 323–324, pl. 1, figs. 14–16; Lamy, 1911: 16, pl. 1, figs. 14–16; Thiele, 1912b: 9–10, pl. 4, figs. 11–13; Arnaud, 1972b: 430; Powell, 1960: 126; Lozouet, 1986: 108; Geiger, 2003: 77. *Scissurella timora* Melvill & Standen, 1912: 345, pl. 48, fig. 2, 2a; Powell, 1951: 61; Powell, 1960: 126; Castellanos, 1980: 136; Ageitos de Castellanos & Landoni, 1988: 8–9, pl. 1, fig. 1; Linse, 1999: 400; Geiger, 2003: 78.

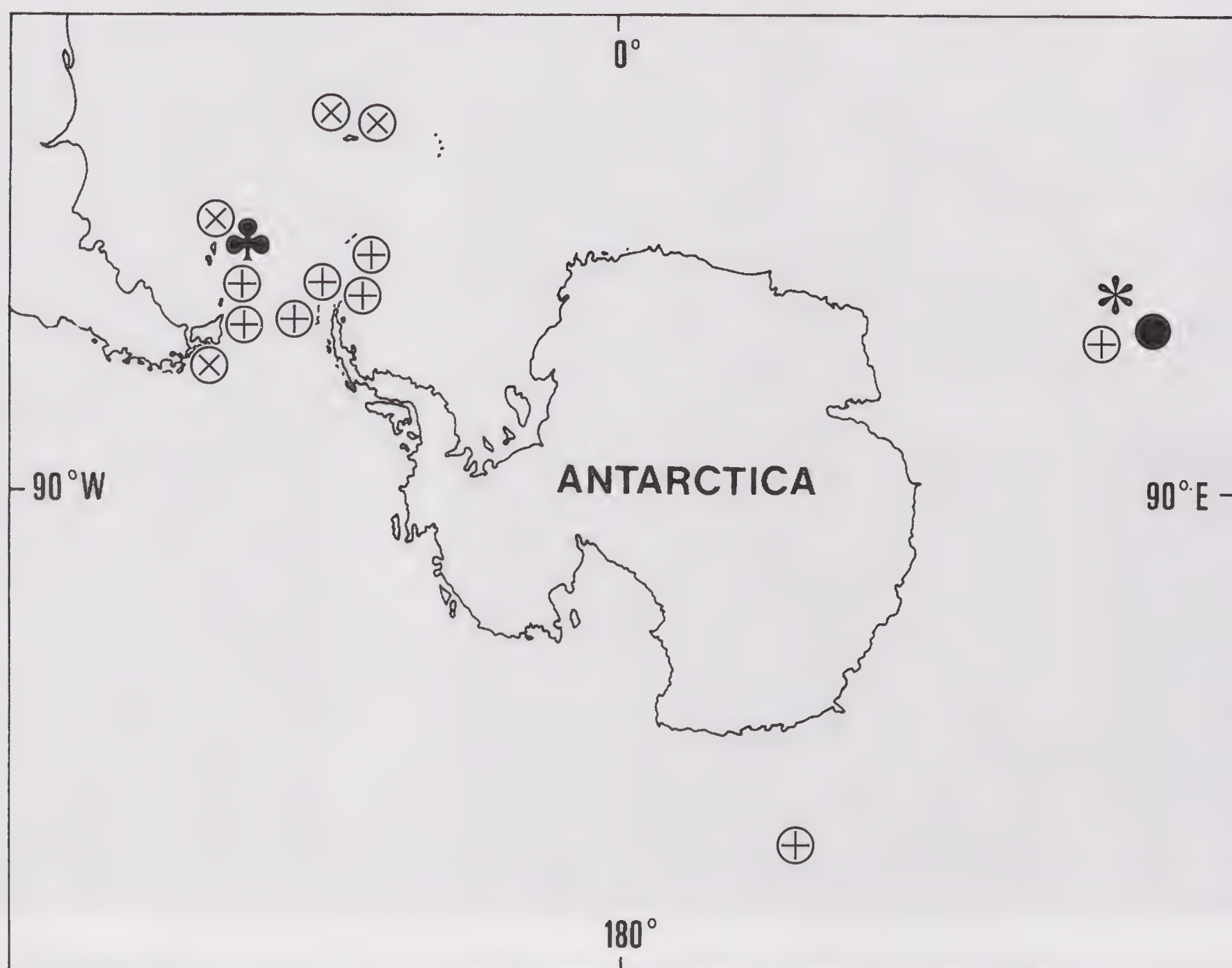


FIG. 123. Distribution of four species of *Scissurella*: *S. petermannensis* material examined (⊕), bibliographic records (⊗); *S. obliqua* (*); *S. supraplicata* (●); and *S. malvinarum* (♣).

Scissurella medioplicata Thiele, 1925: 42, pl. 13, figs. 3–4; Powell, 1960: 126.

Schizotrochus petermannensis: Carcelles, 1953: 162, pl. 1, fig. 7.

Schizotrochus timora: Carcelles, 1953: 161, pl. 1, fig. 6.

Scissurella cf. *petermannensis*: Davolos & Moolenbeek, 2005: 135, figs. 9a–d.

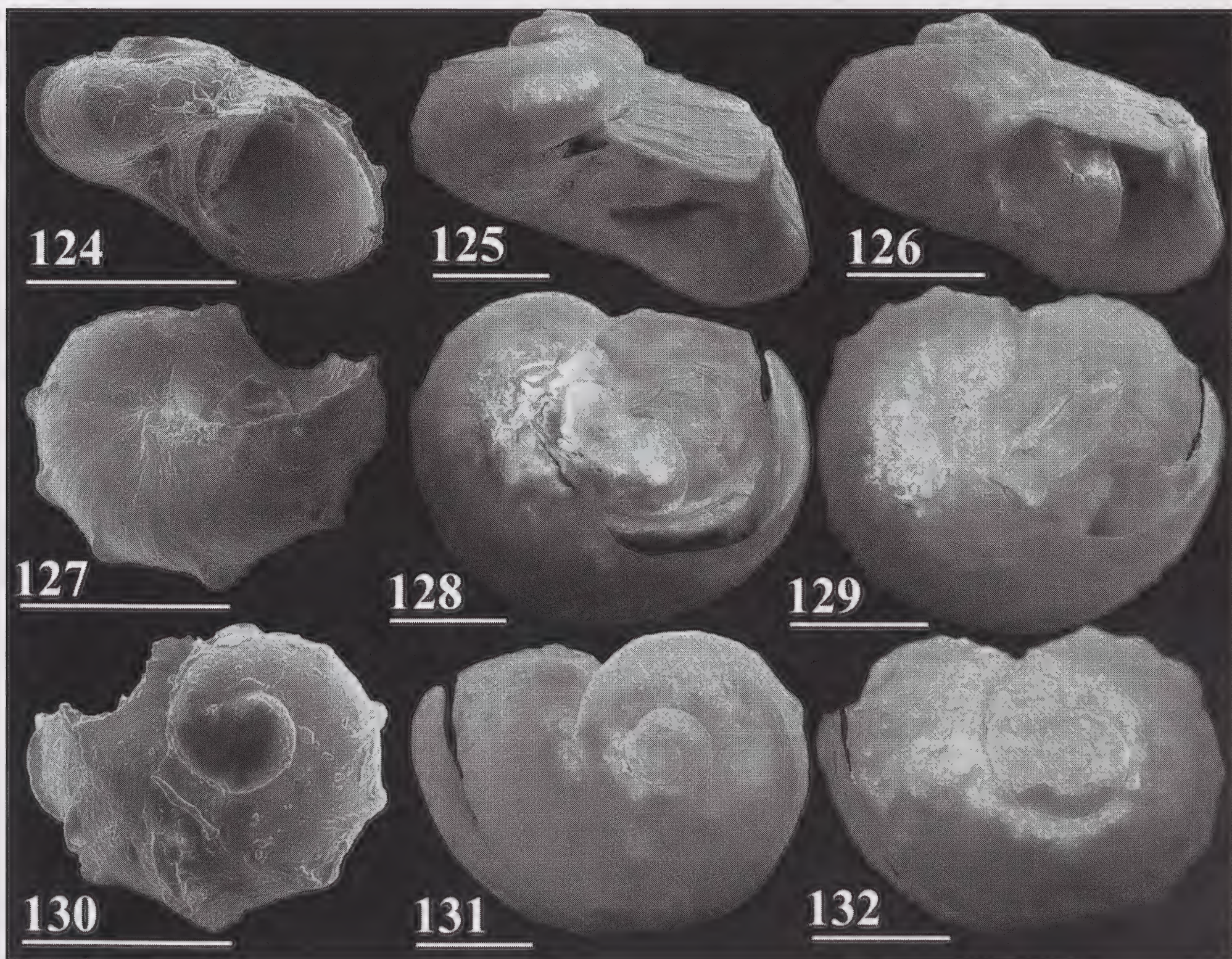
Scissurella cf. *medioplicata*: Davolos & Moolenbeek, 2005: 134, figs. 7a–d.

Type Localities

Petermann Island [65°11'S, 64°10'W, Antarctic Peninsula] (*Scissurella petermannensis*) (OD); Scotia Bay, South Orkneys 9–10 fathoms [16–18 m] (stn 325, Scottish National Antarctic Expedition) (*Scissurella timora*) (OD); Gazelle-Bay, Kerguelen Islands (stn 160, R/V Valdivia) [49°30'S, 69°30'E] (*Scissurella medioplicata*) (OD).

Material Examined

Holotype of *Scissurella petermannensis* (MNHN); lectotype (here designated) (NMSZ 2006109) and two paralectotypes (NMSZ 1921.143.598; NMW 1955.158.091) of *Scissurella timora*; lectotype (here designated) (ZMB-Moll 109.047) and one paralectotype (ZMB-Moll 109.046) of *Scissurella medioplicata*. Beagle Channel: 2 shs, 54°51'S, 68°19'W, 5–10 m (MLP 12081). Southern Argentina: 54°47'S, 64°04'W, Puerto Vancouver, Isla de los Estados, 31 m (3 sps, LACM 71-259). South Shetland Islands: 62°13.8'S, 58°40.2'W, King George Island (1 sh, ZMH 37995). Antarctic Peninsula: Palmer Station [67°42'S, 64°00'W], 1 m (1 sh, NMNZ M.221630). Macquarie Island: 54°38'S, 158°55'E, Green Gorge (1 sh, AMS C.376623).



FIGS. 124–132. *Scissurella petermannensis*. FIGS. 124, 127, 130: Holotype of *Scissurella petermannensis* (MNHN); FIGS. 125, 128, 131: Lectotype of *Scissurella timora* (NMSZ 2006109); FIGS. 126, 129, 131: Paralectotype of *Scissurella timora* (NMSZ 1921.143.598). Scale bars = 500 μ m.

Other Literature Records

Malvinas Island and Strait of Magellan (Castellanos, 1980). South Georgia: 54°22'S, 36°20'W, Cumberland East Bay; 54°20'S, 36°14'W, Penguin Bay, 0.25–1 m (Davolos & Moolenbeek, 2005).

Distribution

Probably circumantarctic, reaching the southern tip of South America. 0.25–18 m (Fig. 123).

Etymologies

Petermannensis (L.): named for its provenance, the Petermann Island; *timora*: *Timoros*

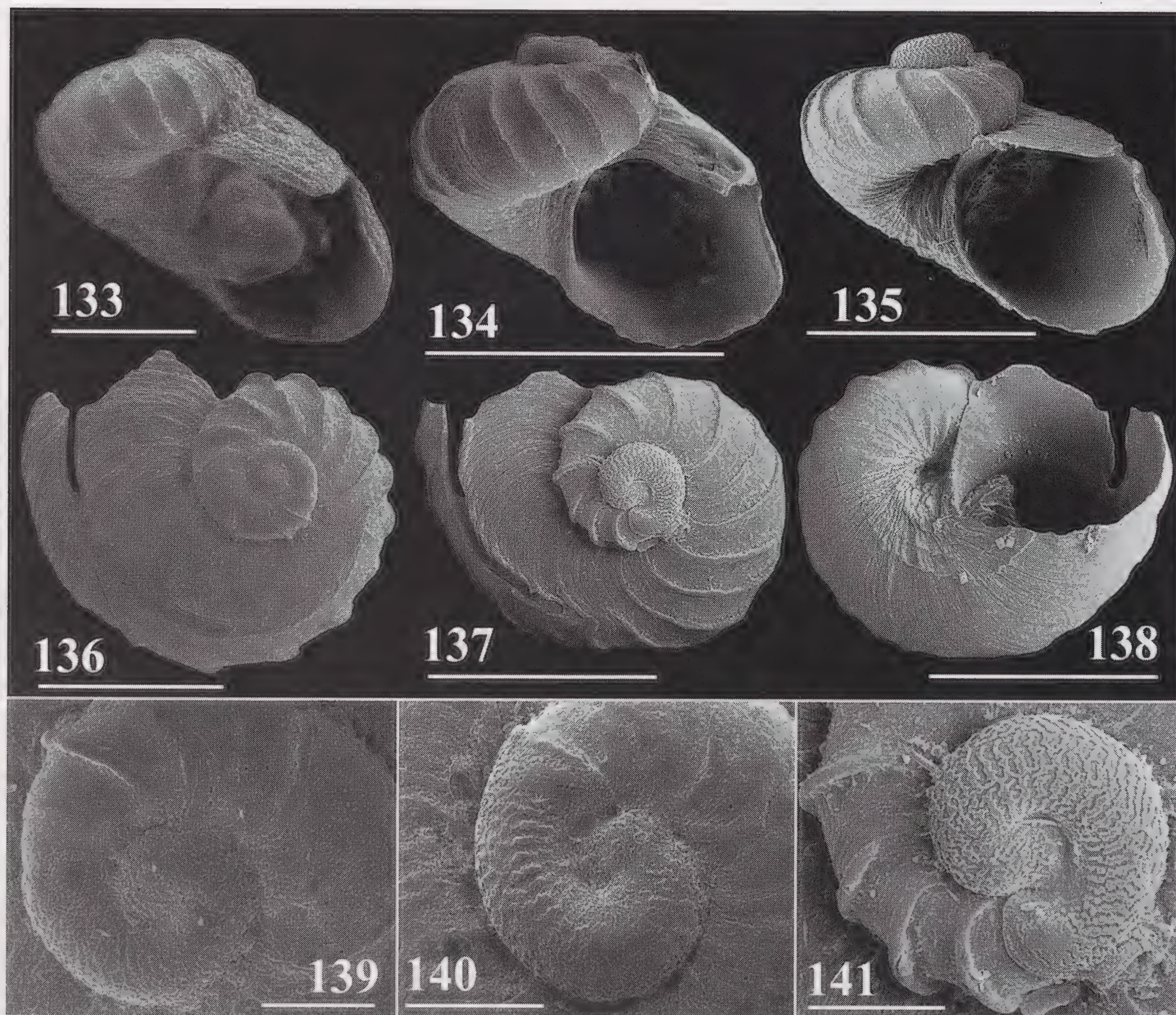
(G.) for honoured; *medioplicata*: *Medio-* (L.) for middle + *-plicata* (L.) for folded, referring to only half of the shell bearing axial ribs.

Diagnosis

The low shell profile with widely spaced and strong axial ribs that extend only over the peripheral portion of the shell distinguish this species from any other known *Scissurella*.

Description

Shell medium size (up to 1.3 mm in diameter), trochiform depressed (Figs. 124–126, 133–135). Protoconch of one whorl, 184–193 µm in diameter, with strong, wide, flat zig-zag

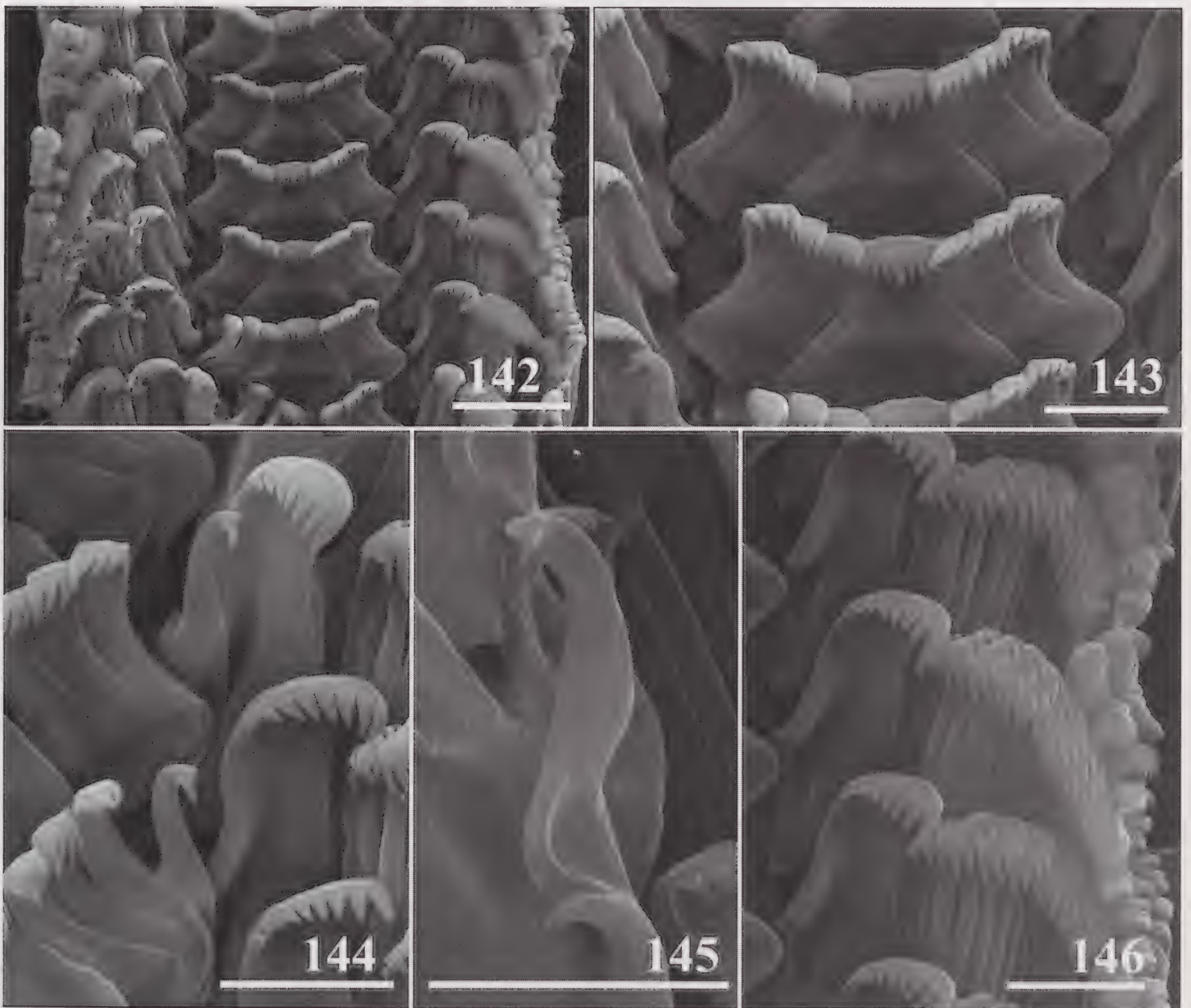


FIGS. 133–141. *Scissurella petermannensis*. FIG. 133: Lectotype of *Scissurella medioplicata* (ZMB-Moll 109.047); FIGS. 134, 136, 139–140: Specimens from 54°51'S, 68°19'W, 5–10 m (MLP 12081); FIGS. 135, 138–139, 141: Specimen from 54°38'S, 158°55'E, Green Gorge, Macquarie Island (AMS C.376623); FIGS. 133–135: Apertural view; FIGS. 136–137: Apical view; FIG. 138: Umbilical view; FIGS. 139–141: Protoconch. Scale bars FIGS. 133–138 = 500 µm; FIGS. 139–141 = 100 µm.

axial ribs, somewhat anastomosing; apertural margin convex, without apertural varix (Figs. 139–141). Teleoconch I of 1 to 1 1/8 whorls, with 10–15 strong, rounded to slightly lamellate axial ribs; axial ornamentation starting sometimes at suture, sometimes at level of selenizone or slightly below periphery (Figs. 130–132, 136–137). Teleoconch II of up to 2/3 whorls. Shoulder slightly convex, overall smooth, only sculptured with irregular growth lines, diminishing in prominence with growth (Figs. 124–126, 133–135). Base with axial ribs and growth lines; occasionally three spiral cords surrounding umbilicus. Umbilicus narrow, deep, with sharp edge transition to base; walls smooth (Figs. 127–129, 138). Selenizone above periphery, keels moderately elevated;

slit open, margins parallel (Figs. 124–126, 133–135). Operculum circular with central nucleus.

Radula (Figs. 142–146): Rachidian tooth triangular at base; cusp nearly straight, with central denticle rounded at the tip; 4 narrower, sharper denticles on each side. Lateral teeth 1–3 similar; cusp with four to five denticles on outer margin. Lateral tooth 4 reduced, with one central denticle on cusp, two smaller denticles on outer side. Lateral tooth 5 wider, larger than other lateral teeth, with 8 strong denticles on inner margin, rounded at tip; outer margin smooth. Radular interlock of central field moderate. Inner marginal teeth with main terminal denticle, and three to four denticles on both inner and outer margins; outer mar-



FIGS. 142–146. *Scissurella petermannensis*: radula of one paralectotype of *Scissurella timora* (NMW 1955.158.091). FIG. 142: General view; FIG. 143: Detail of central and lateral teeth 13; FIG. 144: Detail of lateral teeth 4 and 5; FIG. 145: Detail of lateral teeth 4; FIG. 146: Detail of marginal teeth. Scale bars FIG. 142 = 20 μ m; FIGS. 143–146 = 10 μ m.

ginal teeth spoon shaped, with narrow but long denticles.

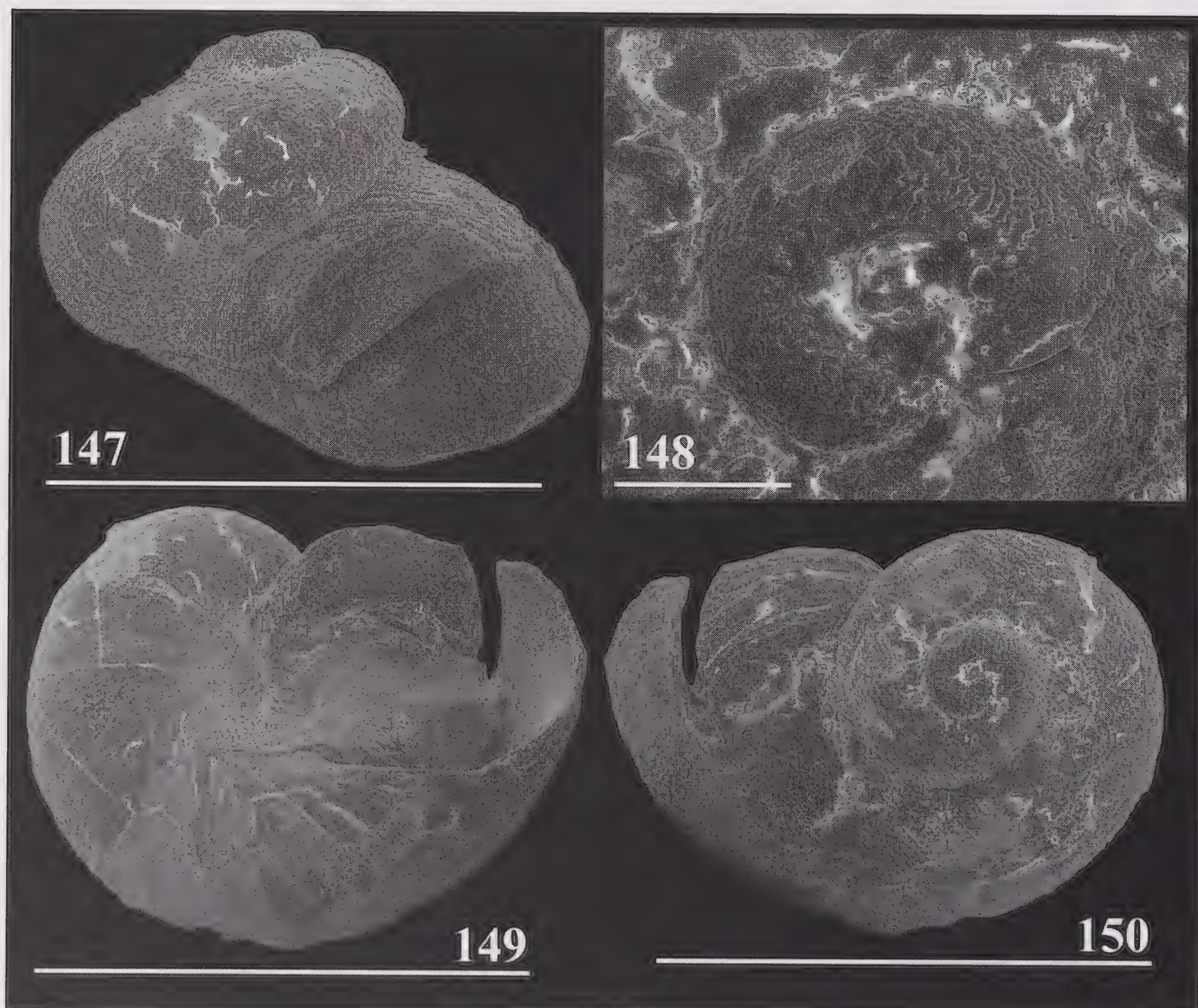
Remarks

Scissurella timora and *S. medioplicata* are here recognized as synonyms of *S. petermannensis*. As these taxa are not well known, we designate here lectotypes for *S. timora* (Figs. 125, 128, 131) and *S. medioplicata* (Fig. 133) with the express taxonomic purpose of taxon stabilization.

The holotype of *Scissurella petermannensis* is a juvenile specimen with only the very beginning of the open slit. The typical descending apertural margin on the last 0.125 whorls are only seen in the type specimens of *S. timora* (Figs. 125, 128, 131). Although the lectotype and paralectotype of *S. timora* are very eroded,

the general shell morphology and ornamentation of these specimens do not differ from that present in the holotype of *S. petermannensis*. The holotype of *Scissurella medioplicata* also agrees in general shell outline with the type specimens of *S. petermannensis* and *S. timora*; due to this fact, this species name is also considered a synonymous. However, it should be noted that the holotype of *S. medioplicata* has more evident axial ribs, but this difference seems to be originated in the better state of preservation of the material, not so eroded as the type specimens of *S. petermannensis* and *S. timora*. In fact, the additional material here studied also show well developed axial ribs.

Cantera & Arnaud (1985) indicated *Scissurella medioplicata* as a synonym of *S. supraplicata*. However, on the basis of the present study, it is clear that the two species



FIGS. 147–150. *Scissurella obliqua*. Lectotype (here designated) (BMNH 1887.2.9.406). FIG. 147: Apertural view; FIG. 148: Protoconch; FIG. 149: Umbilical view; FIG. 150: Apical view. Scale bars FIGS. 147, 149–150 = 1 mm; FIG. 148 = 100 μ m.

are distinct. In *S. supraplicata* the shell is as wide as height, whereas *S. medioplicata* (a synonymy of *S. petermannensis*) has a depressed, laterally expanded shell.

Castellanos (1980) reported *Scissurella petermannensis* (as *S. timora*) from Malvinas Islands and Strait of Magellan. However, these specimens could not be found in the collections of the MLP or MACN, where other material studied by that author is housed.

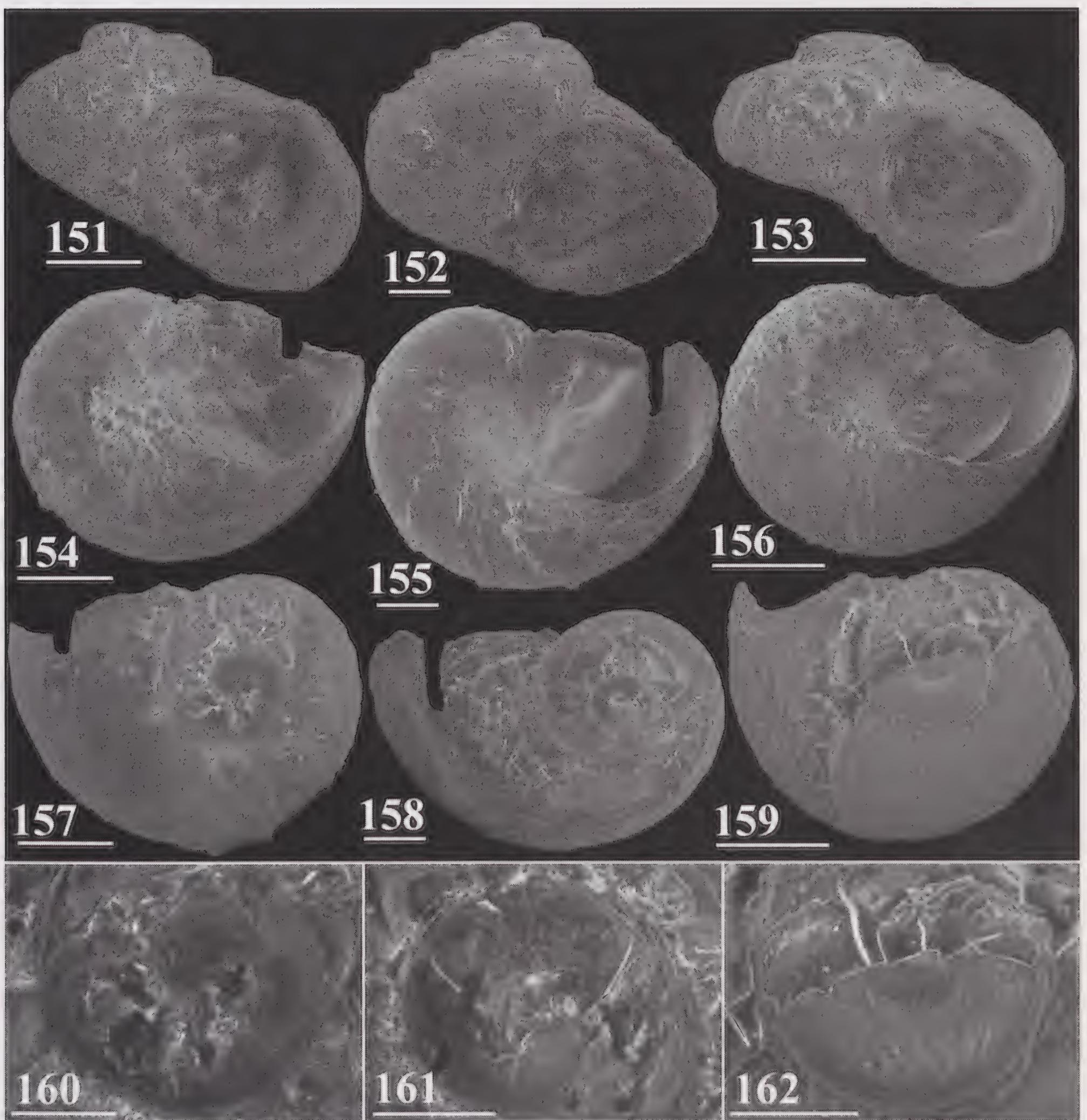
The radula of *Scissurella petermannensis* showed the lateral teeth 1–3 with four to five denticles, whereas scissurellids usually has

three denticles. Whether this character may be of phylogenetic significance remains to be investigated.

Scissurella obliqua Watson, 1886
Figures 123, 147–162

Scissurella obliqua Watson, 1886: 116, pl. 8, fig. 5; Pilsbry, 1890: 58, pl. 58, figs. 20–21; Thiele, 1912b: 10–11, pl. 1, figs. 22–23; Powell, 1960: 126.

Scissurona? obliqua: Lozouet, 1986: 114.
Incisura? obliqua: Geiger, 2003: 75.



FIGS. 151–162. *Scissurella obliqua*. Three paralectotypes (BMNH 1887.2.9.408). FIGS. 151–153: Apertural view; FIGS. 154–156: Umbilical view; FIGS. 157–159: Apical view; FIGS. 160–162: Protoconch. Scale bars FIGS. 151–159 = 200 μ m; FIGS. 160–162 = 100 μ m.

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Misidentifications: <i>Scissurella obliqua</i> : Geiger, 2003: fig. 16E [is <i>Scissurella clathrata</i>].	Remarks We select here the best specimen of the type series as the lectotype (Figs. 147–150) with the express taxonomic purpose of taxon stabilization. <i>Scissurella obliqua</i> is most similar to <i>S. malvinarum</i> n. sp. (see remarks under that species). <i>Scissurella obliqua</i> also resembles <i>Ariella subantarctica</i> in general shell outline, but the two species differ in the morphology of the slit: open in <i>S. obliqua</i> and closed in <i>A. subantarctica</i> . In addition, in <i>S. obliqua</i> the umbilicus is open, whereas in <i>A. subantarctica</i> it is closed by a strong parietal callus, even in the juveniles. Furthermore, <i>A. subantarctica</i> exhibits numerous narrow spiral bands on the last whorl, which are absent in <i>S. obliqua</i> .
Type Locality Royal Sound, Kerguelen Islands [49°28'S, 70°18'E], shore.	
Material Examined Lectotype (here designated, BMNH 1887.2.9.406) and 6 paralectotypes (BMNH 1887.2.9.408).	
Distribution Known only from the type locality (Fig. 123).	
Etymology Based on the “obliquely globose” shell, as originally described.	<i>Scissurella malvinarum</i> n. sp. Figures 123, 163–174
Diagnosis A scissurellid with nearly smooth shell surface, open slit, and shallow umbilicus.	Type Locality 52°25'S, 59°03'W, Sea Lion Island, Malvinas [Falkland] Islands.
Description Shell of medium size (up to 1.1 mm in diameter), trochiform depressed, globose; spire small, low (Figs. 147, 151–153). Protoconch of one whorl, 223–256 µm in diameter, with strong, wide, flat zig-zag axials, somewhat anastomizing; apertural margin convex, without apertural varix (Figs. 148, 160–162). Teleoconch I of 1 1/6 to 1 1/4 nearly smooth whorls, only sculptured with low growth marks (Figs. 150, 157–159). Teleoconch II of up to 1/2 whorls. Shoulder somewhat convex, smooth, with minor growth marks; base continuous with umbilical cavity, nearly smooth, with minor growth marks. Aperture rounded-oblong, roof overhanging. Selenizone above periphery, keels very low, moderately strong, with irregular growth lunules; slit with low keels, open, with parallel margins (Figs. 147, 151–153). Umbilicus moderately wide, shallow, not covered by callus (Figs. 149, 154–156). Operculum round, multispiral with central nucleus, covering approximately 80% of aperture. Animal unknown.	Type Material Holotype (NMSZ 2006110) and 15 paratypes (NMSZ 1992167.60101) from type locality.
	Distribution Known only from the type locality (Fig. 123).
	Etymology Named after the type locality, the Malvinas Islands.
	Diagnosis A scissurellid with a deep umbilicus surrounded by 2–6 spiral cords, a mesh-like pattern as protoconch ornamentation, and open slit.
	Description Shell of medium size (up to 1.2 mm in diameter), trochiform depressed, globose, low spired (Figs. 163–165). Protoconch of one whorl, 205–258 µm in diameter, sculptured with strong, flat irregular cords, forming a mesh-

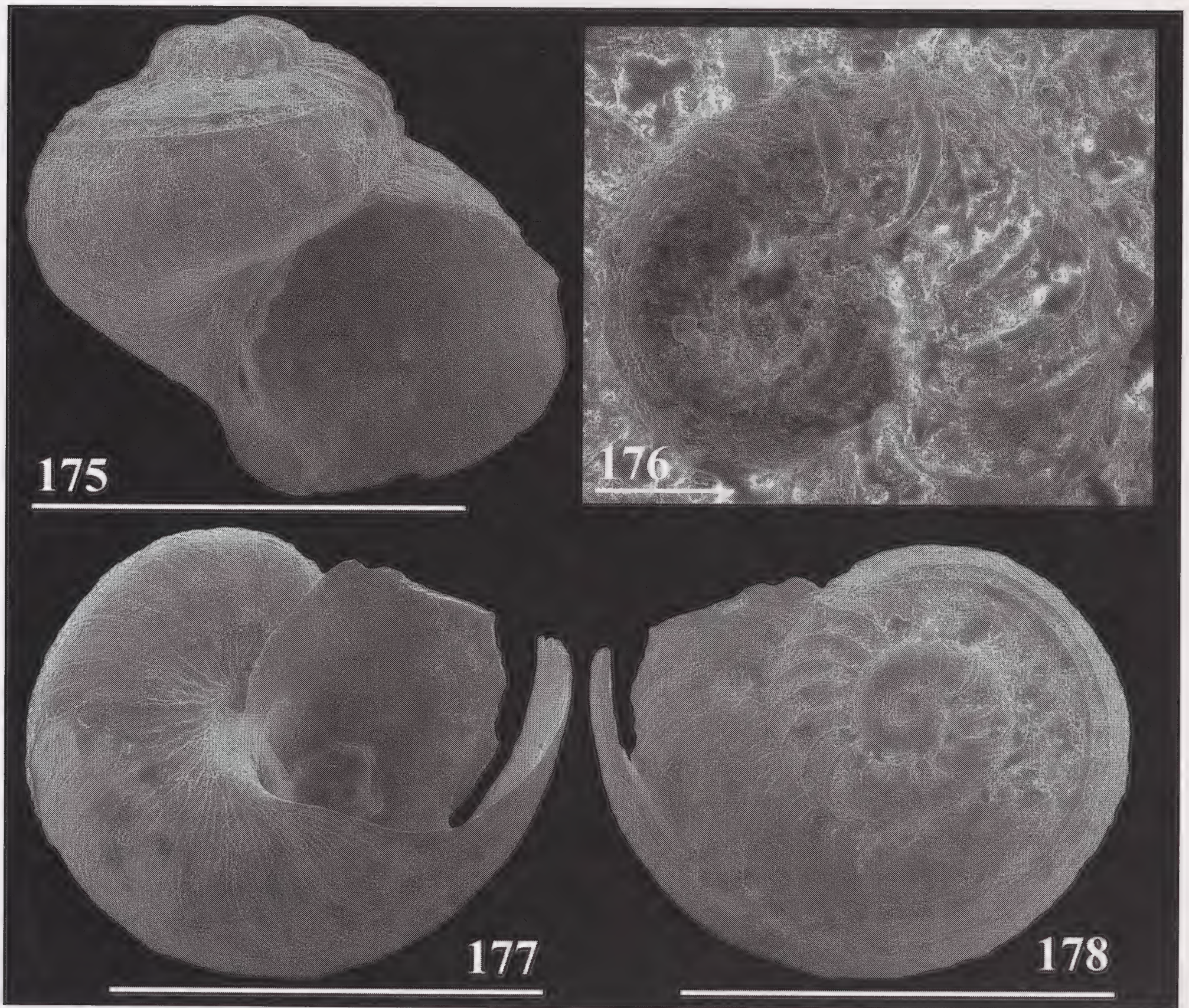


FIGS. 163–174. *Scissurella malvinarum*. FIGS. 163, 166, 169, 172: Holotype (NMSZ 2006110); FIGS. 164–165, 167–168, 170–171, 173–174: Paratypes (NMSZ 1992167.60101); FIGS. 163–165: Apertural view; FIGS. 166–168: Umbilical view; FIGS. 169–171: Apical view; FIGS. 172–174: Protoconch. Scale bars FIGS. 163–171 = 500 μ m; FIGS. 172–174 = 200 μ m.

like pattern; apertural margin convex, without apertural varix (Figs. 172–174). Teleoconch I of one whorl; teleoconch II of up to one whorl (Figs. 169–171). Shell surface sculptured with low growth marks and 2–6 flat spiral cords surrounding the umbilicus. Umbilicus wide,

deep (Figs. 166–168). Base continuous with umbilical cavity. Aperture rounded oblong, roof overhanging. Selenizone above periphery, keels very low, with irregular growth lunules; slit open, with parallel margins (Figs. 163–165). Animal unknown.

Remarks	Distribution
<i>Scissurella malvinarum</i> is most similar to <i>S. obliqua</i> from which it differs in having a deeper umbilicus and selenizone more displaced towards periphery. In addition, <i>S. malvinarum</i> shows spiral cords surrounding the umbilicus, which are completely absent in <i>S. obliqua</i>. Furthermore, the protoconch ornamentation of <i>S. malvinarum</i> shows a mesh-like pattern, while anastomosing zig-zag axials are present in <i>S. obliqua</i>. Another similar species is <i>Ariella subantarctica</i>, which differs from <i>Scissurella malvinarum</i> in having a close foramen, the umbilicus filled by a callus, and more developed shell sculptured. <i>Scissurella malvinarum</i> is a mature <i>Scissurella</i> and not a juvenile <i>Sinezona</i> with open slit. The last quarter of the whorl is descending while the margins of the slit do not converge (Fig. 164), a clear sign of maturity as discussed by Geiger (2003, 2006a).	Known only from the type locality (Fig. 123).
	Etymology
	<i>Supra</i>:- (L.) for above, on top; <i>-plicata</i>: (L.) for folded.
	Diagnosis
	Shell inflated, with strong axial ribs on teleoconch I, slit open, and narrow umbilicus.
	Description
	Shell medium in size (1.25 mm in diameter in the holotype), trochiform, inflated-bulbous (Fig. 175). Protoconch of one whorl, about 220 µm in diameter; apertural margin convex, without varix (Fig. 176); protoconch ornamentation unknown (very eroded in only known specimen). Teleoconch I of one whorl, sculptured with 17 strong axial ribs (Fig. 178). Teleoconch II of about one whorl, with convex shoulder and inflated base, sculptured with axial growth folds; axials making more prominent toward umbilicus (Figs. 175, 177). Selenizone above periphery, surrounded by low keels, having low growth marks; slit open, with parallel margins (Fig. 175). Umbilicus narrow (Fig. 177). Aperture rounded. Animal unknown.
	Remarks
	<i>Scissurella supraplicata</i> resembles <i>S. clathrata</i> in general shell outline, but these species differ in shell ornamentation: while the former shows strong axial sculpture (particularly in teleoconch I), the latter has a delicate cancellate pattern. In addition, the umbilicus is narrower in <i>S. supraplicata</i> than in <i>S. clathrata</i>. Another similar species is <i>Sinezona mouchezi</i>, which differs from <i>Scissurella supraplicata</i> by having a closed foramen, a more laterally expanded shell, and wider umbilicus. Cantera & Arnaud (1985) indicated <i>Scissurella medioplicata</i> as a synonym of <i>Scissurella supraplicata</i>, an opinion not shared here: <i>S. medioplicata</i> [a junior synonymy of <i>S. petermannensis</i>] has a more laterally expanded shell, with stronger axial ribs and a deeper umbilicus than <i>S. supraplicata</i>.
<i>Scissurella supraplicata</i> Smith, 1875 Figures 123, 175–178 <i>Scissurella supraplicata</i> Smith E. A., 1875: 72 (not illustrated); Crosse, 1877: 10; Smith, 1879: 176, pl. 9, fig. 5, 5a; Paetel, 1888: 289; Pilsbry, 1890: 54–55, pl. 58, figs. 27–28; Thiele, 1912b: 10, pl. 1, figs. 20–21; Melvill & Standen, 1912: 345; Thiele, 1925: 42; Powell, 1957: 124; Powell, 1960: 126; Cantera & Arnaud, 1985: 32; Geiger, 2003: 78. <i>Scissurella</i> (?) <i>supraplicata</i>: Lozouet, 1986: 108. Misidentifications: <i>Scissurella supraplicata</i>: Melvill and Standen, 1912: 345 [is <i>Anatoma conica</i>]. <i>Schizotrochus supraplicata</i> [sic]: Carcelles & Williamson, 1951: 251 [is <i>A. conica</i>]. <i>Schizotrochus supraplicatus</i>: Carcelles, 1953: 162 [is <i>A. conica</i>]. <i>Scissurella supraplicata</i>: Ageitos de Castellanos & Landoni, 1988: 8 [is <i>A. conica</i>].	
Type Locality	
Swain's Bay, Kerguelen Island [49°42'S, 69°57'E] (OD).	
Material Examined	
Holotype (BMNH. 1876.8.28.33).	



FIGS. 175–178. *Scissurella supraplicata*. Holotype (BMNH 1876.8.28.33). FIG. 175: Apertural view; FIG. 176: Protoconch; FIG. 177: Umbilical view; FIG. 178: Apical view. Scale bars FIGS. 175, 177–178 = 1 mm; FIG. 176 = 100 μ m.

Carcelles & Williamson (1951) and Ageitos de Castellanos & Landoni (1988) included *Scissurella supraplicata* in the list of species from the Magellan Region, based on the record of Melvill & Standen (1912), which, as indicated above, does not correspond to this species but to *Anatoma conica*. The same source of error seems to be the origin of the inclusion of *S. supraplicata* in the list of species by Carcelles (1953).

Scissurella dalli Bartsch, 1903, *nomen dubium*

Scissurella dalli Bartsch, 1903: 90–91; Thiele, 1912b: 8; Carcelles, 1950: 50; Ageitos de Castellanos & Landoni, 1988: 9; Geiger, 2003: 76.

Schizotrochus dalli: Carcelles & Williamson, 1951: 251.

Type Locality

Gulf of St. George, Patagonia [$\sim 46^{\circ}$ S, 66° W, Argentina] (OD).

Etymology

Named after William Healy Dall (1845–1927).

Remarks

The species was not illustrated by Barsch (1903), and has never been figured elsewhere. Bartsch's description lacks any discernible

detail necessary to evaluate the species. The type material is missing from USNM (Geiger, pers. obs. 2/2004) where it was originally deposited (fide Bartsch, 1903). The generic placement of this species is tentative; Bartsch noted the selenizone “near periphery”, which applies to *Scissurella*, while in *Anatoma* the selenizone is at the periphery; *Anatoma* and *Scissurella* were not used as distinct genera in the early 20th century. Whether Bartsch’s species was based on an immature specimen of *Sinezona* remains open.

Ariella Bandel, 1998

Type Species (OD): *Ariella haliotimorpha* Bandel, 1998.

Diagnosis

Shell approximately 1 mm, trochiform depressed, protoconch with axial sculpture; foramen above periphery, no selenizone. More comprehensive diagnoses and discussions have been provided elsewhere (Geiger, 2003, 2006a; Geiger & Jansen, 2004b).

Remarks

Scissurella and *Sinezona* show a selenizone; *Satondella* has the walls of the foramen forming a chimney; *Scissurella* also has an open slit. The validity of the genus is debatable, as discussed by Geiger (2003); we conservatively retain it here.

Ariella subantarctica (Hedley, 1916)
Figures 179, 180–196

Schismope subantarctica Hedley, 1916b: 36, pl. 5, figs. 54–55; Finlay, 1927: 341.

Sinezona subantarctica: Powell, 1955: 46; Powell, 1960: 126; Powell, 1979: 35; Spencer & Willan, 1995: 13.

Scissurella obliqua Watson: Cantera & Arnaud, 1985: 31 [non Watson, 1886].

Sinezona? subantarctica: Lozouet, 1986: 111.

? *Sinezona* sp.: Branch et al., 1991: 47, 58, 62.

Ariella subantarctica: Geiger, 2003: 75, fig. 15g.

Type Locality

Aerial Cove, Macquarie Island [54°29’S, 158°57’E] (OD).

Material Examined

Macquarie Islands: 54°30’S, 158°53’E, Handspike Point (18 shs, AMS C.376612); Aerial Cove: 54°29’S, 158°57’E, 5 m (6 sps, AMS C.376621); 5 m (2 sps, NMNZ M.152863). Crozet Islands: 46°25’S, 52°12’W, South Marin Bay, in clumps of *Durvillea* (2 shs, MNHN). Southern Chile: 50°11’S, 74°48’W, Bahía Tom, 15 m (2 shs, LACM 73-72); 46°35’S, 75°30’W, Bahía San Andres, 1 m (11 sps, LACM 73-73). Southern Argentina: 54°48’S, 65°16’W, Bahía Buen Suceso, 0 m (1 sh, LACM 71-270).

Distribution

Macquarie Island, Crozet Islands, Magellan Region. 0–15 m (living specimens: 1–5 m) (Fig. 179).

Etymology

Referring to its provenance, a subantarctic island.

Diagnosis

Shell depressed, with prominent umbilical callus, closed foramen, no obvious selenizone, and sculptured with axial ribs and spiral cords.

Description

Shell medium size (up to 1.3 mm in diameter), trochiform-depressed (Figs. 182–184). Protoconch of 1 1/8 to 1 1/2 whorls, 198–202 µm in diameter, with strong irregular flattened anastomosing axial ribs; apertural margin slightly convex, with varix connected to embryonic cap (Figs. 191–193). Teleoconch I of 1 1/6–1 5/8 whorls, sculptured with about 40 axial ribs of variable degree of development, and delicate spiral sculpture (Figs. 180, 188–190). Teleoconch II of 1/8 whorl. Shoulder slightly convex; axial sculpture as on teleoconch I, additionally one dozen spiral cords increasing in width towards apertural margin. Base with 8–9 spiral cords; axial sculpture weak (Figs. 181–187). Umbilicus open in juveniles, closed by callus in adult specimens (Figs. 185–187). Selenizone extremely short or absent; foramen lenticular, with very low keels, continued anteriorly by raphe (Figs. 180–181, 185–190). Aperture broadly rounded, oblique to shell axis, roof overhang-



FIG. 179. Distribution of *Ariella subantarctica* (⊗) and *Sinezona mouchezi* (◆).

ing; umbilical callus as extension of peristome. Operculum very thin, multispiral, with central nucleus, covering approximately 60% of aperture width.

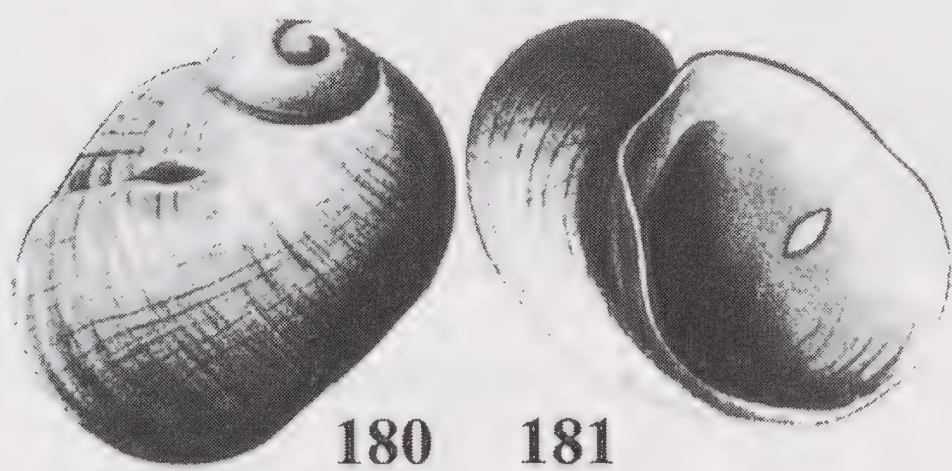
Radula (Figs. 194–196): Rachidian tooth with broadly triangular base; cusp nearly straight at lateral edges, V-shaped distally, with one main rounded denticle and 2–3 smaller denticles at each side, reducing size towards base.

Lateral teeth 1–3 similar, with three strong, sharp denticles on outer edge. Lateral tooth 4 reduced, with one small point on either side of main denticle. Lateral tooth 5 larger and wider than other laterals; cusp smooth on outer edge, with 7 denticles on inner edge. Radular interlock of central field moderate. Inner marginal teeth with one main central denticle, two denticles on inner edge of cusp, and three denticles on outer edge. Outer marginals spoon-shaped.

Remarks

According to Powell (1955), the holotype of *Ariella subantarctica* was originally housed at the AMS, but this material was not found during a visit to this museum in 2001 (Geiger, pers. obs.). However, the identity of this species could be confirmed by the examination of several topotypical specimens.

Ariella subantarctica resembles in general shell outline *Scissurella obliqua*, from which it differs by having a close slit forming a fora-

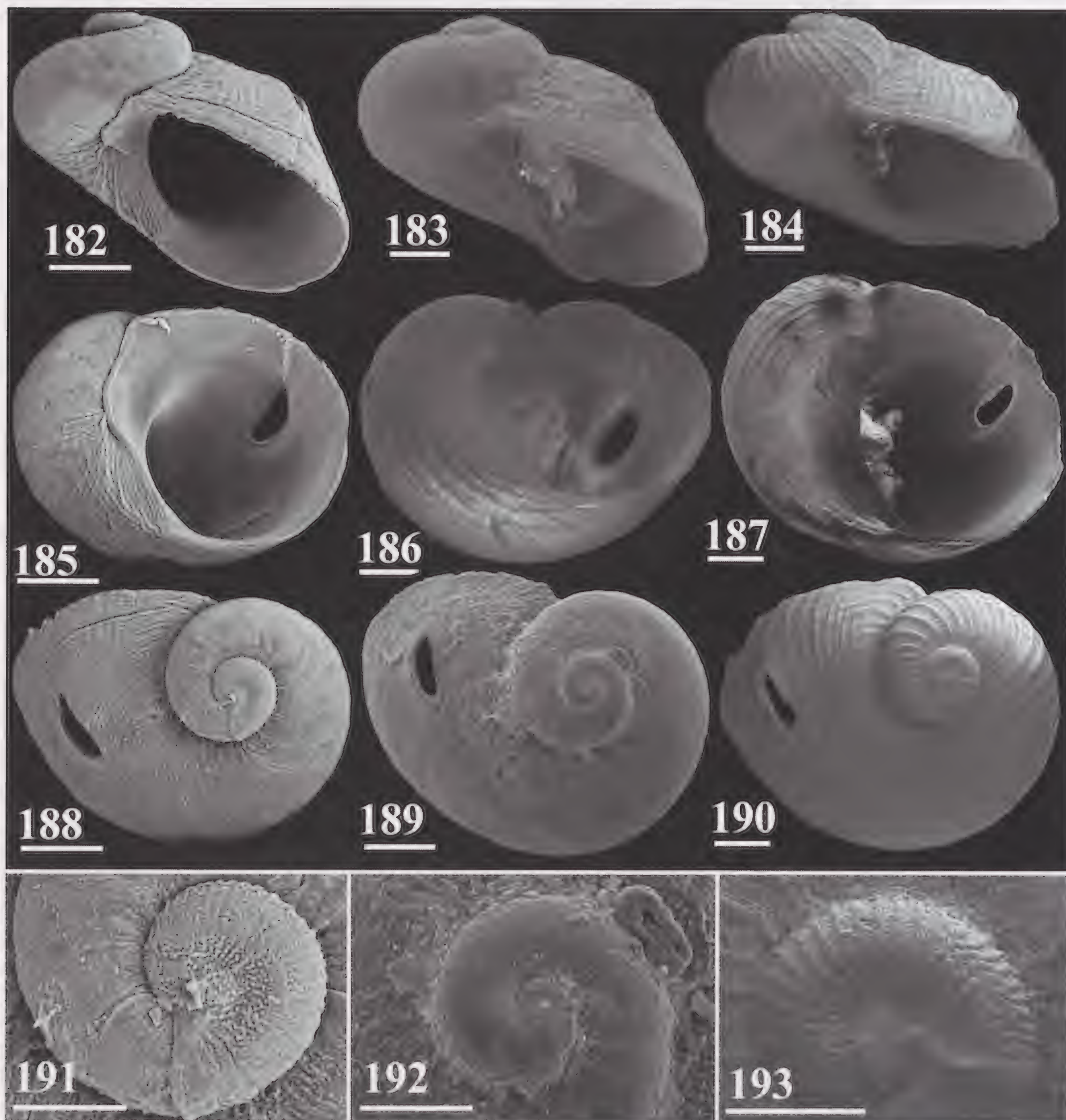


FIGS. 180–181. *Ariella subantarctica*. Original figures by Hedley (1916b).

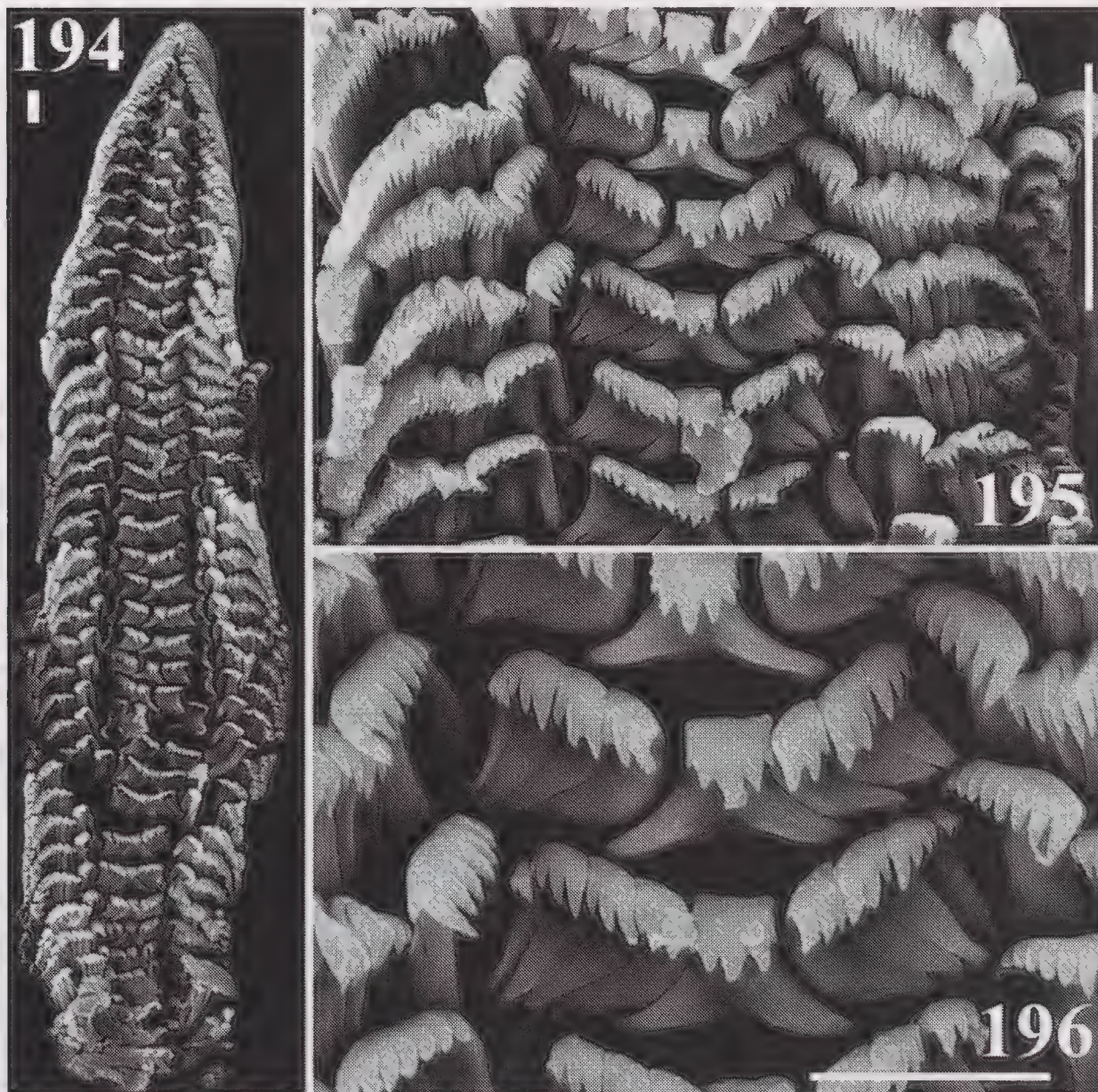
men, well-developed axial and spiral sculpture, and the umbilicus covered by a strong callus. The other species from the area with a closed slit is *Sinezona mouchezi*, but the latter has a long selenizone (which is absent in *A. subantarctica*), a higher spire, more distinct axial ribs

on the teleoconch, and fewer straight axials on the protoconch.

The re-examination of the material reported by Cantera & Arnaud (1985) as *Scissurella obliqua* (MNHN) showed that it is referable to *Ariella subantarctica*.



FIGS. 182–193. *Ariella subantarctica*. FIGS. 182, 185, 188, 191: Specimen from 54°30'S, 158°53'E, Handspike Point, Macquarie Islands (AMS C.376612); FIGS. 183, 186, 189, 192: Specimen from Aerial Cove, Macquarie Island, 5 m (NMNZ M.152863); FIGS. 184, 187, 190, 193: Specimen from 46°35'S, 75°30'W, Bahía San Andres, 1 m (LACM 73-73); FIGS. 182–184: Apertural view; FIGS. 185–187: Umbilical view; FIGS. 188–190: Apical view; FIGS. 191–193: Protoconch. Scale bars FIGS. 182–190 = 200 μ m; FIGS. 191–193 = 100 μ m.



FIGS. 194–196. *Ariella subantarctica*. Radula of a specimen from 54°29'S, 158°57'E, Aerial Cove, 5 m (AMS C.376621); FIG. 194: Entire radula; FIG. 195: Full width of radular ribbon; FIG. 196: Central field enlarged. Scale bars = 10 μ m.

Genus: *Sinezona* Finlay, 1926

Type Species (OD): *Schismope brevis* Hedley, 1904.

Diagnosis

Shell 0.7–3 mm, trochiform, more or less depressed; protoconch usually with axial sculpture, sometimes smooth or with spiral elements; selenizone, foramen above periphery. More comprehensive diagnoses and discussions have been provided elsewhere (Geiger, 2003, 2006a; Geiger & Jansen, 2004b; Marshall, 2002).

Remarks

Scissurella has an open slit, *Ariella* lacks the selenizone, *Satondella* has the foramen forming a chimney.

Sinezona mouchezi (Vélain, 1876)
Figures 179, 197–212

Schismope mouchezi Vélain, 1876: 285;
Vélain, 1877: 119–120, pl. 4, figs. 7–8; Paetel,

1888: 289; Pilsbry, 1890: 62, pl. 57, figs. 18–19; Thiele, 1912b: 25, pl. 3, figs. 21–22.

Sinezona mouchezi: Lozouet, 1986: 111; Geiger, 2003: 79.

Type Locality

St. Paul Island [38°44'S, 77°30'E], subtidal to 45 m (OD).

Material Examined

Lectotype (here designated) and 3 paralectotypes (MNHN).

Distribution

Known only from the type locality (Fig. 179).

Etymology

Named after the Commandant Mouchez.

Diagnosis

Shell inflated, sculptured with strong axial ribs, and having a wide umbilicus and large foramen.

Description

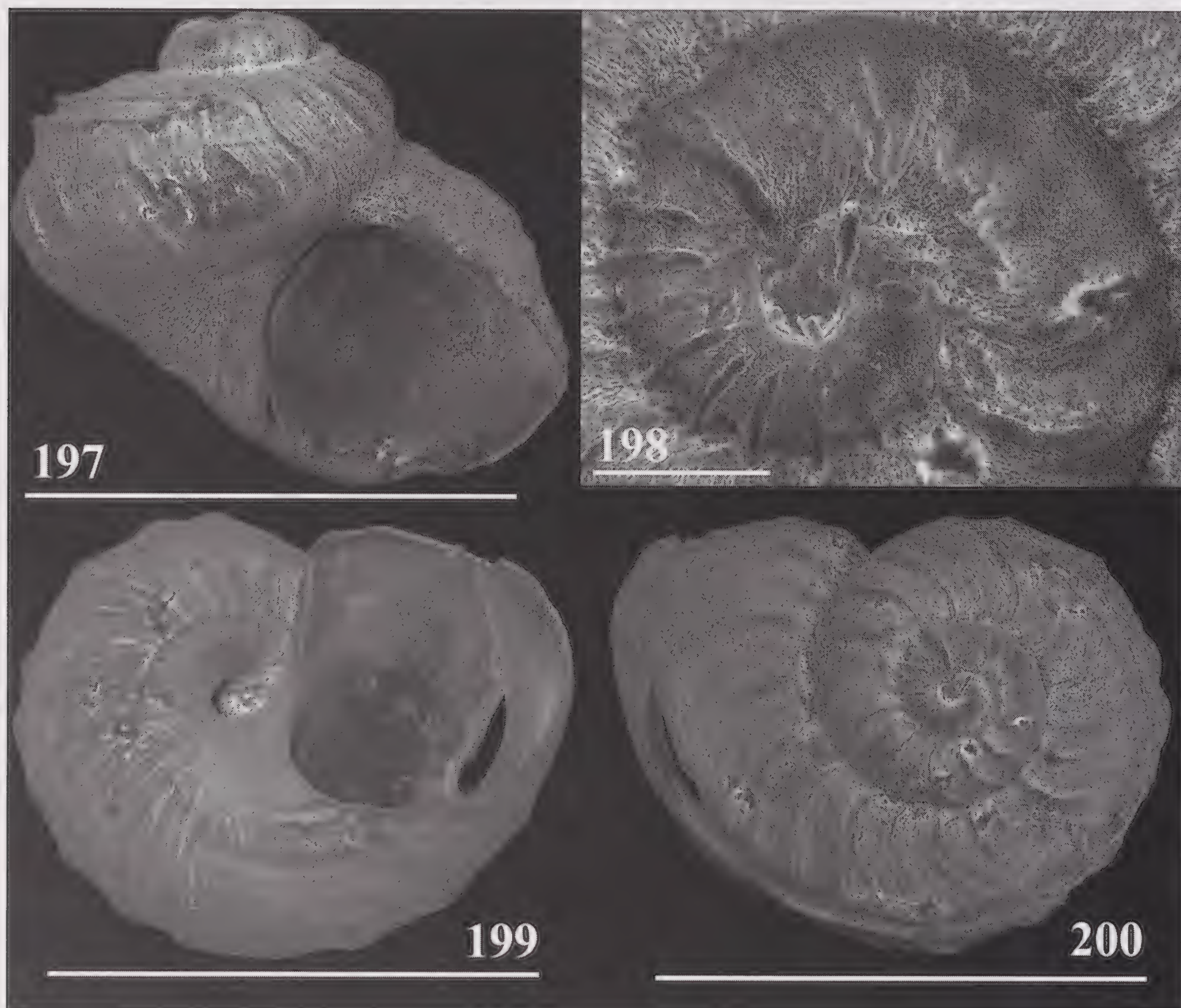
Shell medium in size (up to 2 mm in diameter), trochiform, inflated, last whorl somewhat laterally expanded (Figs. 197, 201–203). Protoconch of one whorl, 193–203 μm in diameter; protoconch sculptured with 13–15 strong axial ribs, distinct varix connected to embryonic cap (Figs. 198, 210–212). Teleoconch I of 1 $\frac{1}{8}$ whorls, sculptured with 13–14 strong axial ribs, 6 narrower spiral threads (Figs. 200, 207–209). Teleoconch II of up to $\frac{7}{8}$ whorls, with convex shoulder, inflated base, sculptured with strong axial ribs, and spiral threads; 14–16 axial ribs on shoulder, about 13 on base, diminishing in prominence toward umbilicus; spirals regularly distributed, 6–7 on shoulder, 7–8 on base (Figs. 197–199, 201–209). Selenizone above periphery, sur-

rounded by low keels, having low growth marks; slit closed forming foramen (Figs. 200, 207–209). Umbilicus wide (Figs. 199, 204–206). Aperture rounded. Animal unknown.

Remarks

Sinezona mouchezi closely resembles *Scissurella supraplicata* from which it differs by having a close foramen and wider umbilicus.

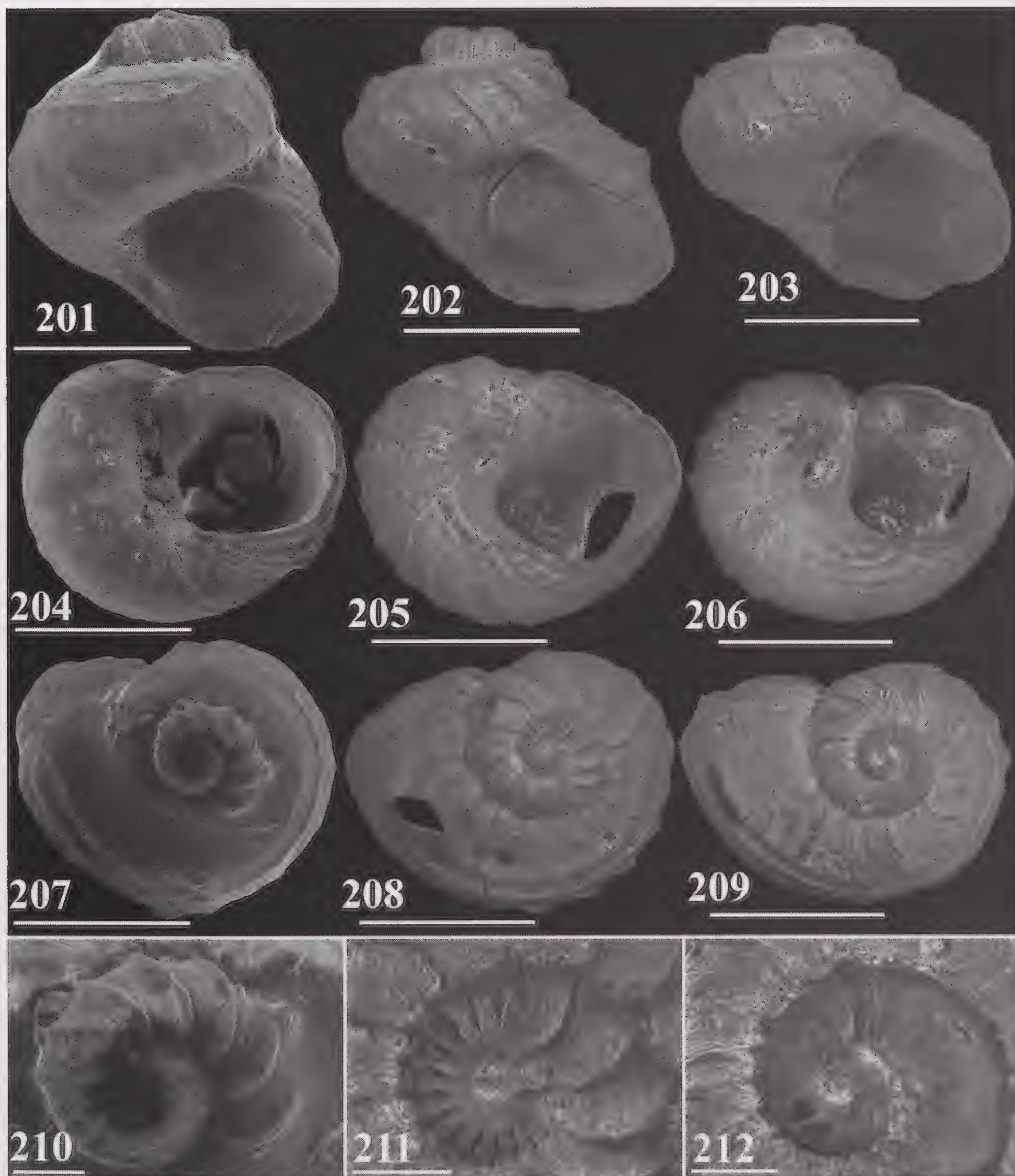
Among the four specimens that represent the type series of *Sinezona mouchezi* two “varieties” can be recognized: three of the specimens have the above described set of characters; the other specimen has a taller spire, a less laterally expanded shell, and the axial and spiral ornamentation is almost absent on the last whorl; these characteristics are correlated with a larger overall size of teleoconch II. How-



FIGS. 197–200. *Sinezona mouchezi*. Lectotype (here designated). FIG. 197: Apertural view; FIG. 198: Protoconch; FIG. 199: Umbilical view; FIG. 200: Apical view. Scale bars FIGS. 197, 199–200 = 1 mm; FIG. 198 = 100 μm .

ever, the number of protoconch and teleoconch I whorls, and their ornamentation is the same in all the specimens; consequently, we consider these differences as infraspecific variability. None of the above-mentioned specimens correspond to the material figured by Vélain (1877), which has the teleoconch with

a larger number of whorls ($3 \frac{1}{4}$), a taller spire, and a more prominent shell sculpture. Taking into account this fact and that the young specimens of *S. mouchezi* could be confused with *Scissurella supraplicata*, we designate here a lectotype of the former with the express purpose of taxon stabilization.



FIGS. 201–212. *Sinezona mouchezi*. Paralectotypes. FIGS. 201–203: Apertural view; FIGS. 204–206: Umbilical view; FIGS. 207–209: Apical view; FIGS. 210–212: Protoconch. Scale bars FIGS. 201–209 = 500 μ m; FIGS. 210–212 = 100 μ m.

DISCUSSION

In the present study the identity, taxonomic status, and distribution of 14 of the 15 nominal species of scissurellids and anatomids previously reported from the Antarctic and Sub-Antarctic waters are evaluated; the remaining species (*Scissurella georgica*) was recently and properly described and figured by Davolos & Moolenbeek (2005), and consequently is not redescribed herein. Out of the 15 nominal species known from the area, 11 proved to be valid, another species (*Scissurella dalli*) is a *nomen dubium*, and the remaining three species (*Scissurella eucharista*, *S. timora*, and *S. medioplicata*) proved to be synonyms. The new species were described at the time and were not recognized as mere variants of described species because of the limited material available and the wide geographic distribution of the species. In addition, three other species examined during this study proved to be new to science, and are also described herein: *Thielella weddelliana*, *T. argentinae*, and *Scissurella malvinarum*.

Many of the taxonomic uncertainties regarding the Sub-Antarctic and Antarctic scissurellid and anatomid species can be accounted for species having been described based on single specimens, often in poor preservational state, and that they were never properly illustrated. It resulted in numerous misidentifications here detected in literature. In the present study, this limitation was overcome by studying large collections from the Southern Ocean and several topotypic specimens, and using SEM for all aspects of the investigation.

New Morphological and Anatomical Observations

The present work has shown some further intrageneric variability with respect to radular morphology. The rachidian tooth of Scissurellidae had considered previously to be diagnostically shaped, with a V-shaped cusp (Geiger, 2003). In *Scissurella clathrata* and *S. petermannensis*, however, the cusp is approximately parallel to the row of teeth, a condition previously reported only from anatomid species. However, the number of denticles present in the cusp continues being an adequate character to separate Scissurellidae and Anatomidae: in scissurellids there is consistently a smaller number of proportionally larger denticles. The absolute size of the denticles is approximately the same in *Scissurella*

clathrata and *Thielella amoena*. The rachidian tooth of *Scissurella clathrata* is approximately 4 μm wide and has five denticles, whereas in *Thielella amoena* the rachidian tooth is 8 μm wide with 9–11 denticles. On the other hand scissurellid species over a wide size range from *Scissurella kaiserae* Geiger, 2006, of 0.6 mm to *Sinezona plicata* (Hedley, 1899) up to 3 mm in diameter, all have a very similar arrangement of the rachidian tooth with four or five denticles (Geiger & Jansen, 2004b; Geiger, 2006a). Ontogenetic data on the radula in either Scissurellidae or Anatomidae is not available.

The denticles on lateral tooth five are also diagnostic for Scissurellidae and Anatomidae. Scissurellidae have denticles only on the inner margin of the cutting edge; the outer edge is smooth. In contrast, all Anatomidae species investigated thus far have well-developed and narrower denticles on both sides of the cutting edge.

Another diagnostic character is the orientation of the lateral tooth five on the ribbon. This tooth is oriented with the tip pointing to midline of radula or parallel to radular axis in anatomids, whereas it points towards marginals in scissurellids.

In the present study, we provide for the first time information of the jaw plate for an anatomid (*Anatoma euglypta*). The relevance of this character in systematic is still unknown, and should be evaluated after its examination in other species and genera.

The anatomy of scissurellids and anatomids is currently known in only few species (Barret, 1856; Vayssière, 1894; Pelseneer, 1899, 1903; Bourne, 1910; Fretter & Graham, 1962, 1976; Herbert, 1986; Hazprunar, 1989; Strasoldo, 1991). Among the species occurring in Sub-Antarctic and Antarctic waters, some data on the gross anatomy is only available for *Anatoma euglypta* (Pelseneer, 1903). We obtained here some additional information on the anatomy of *A. euglypta* and the first data for *Scissurella clathrata*, *Thielella amoena*, and *T. weddelliana*. All these species agree in general morphology with the species from tropical regions and the northern hemisphere (e.g., Herbert, 1986; Strasoldo, 1991).

The present study revealed the existence of some differences in the morphology of cephalic tentacles among the species here examined: they were long and cylindrical in *Anatoma euglypta* and *Thielella amoena*, long and lanceolated in *Anatoma weddelliana*, and short and foliated in *Scissurella clathrata*; all of them

showed papillate tentacles. In other species for which this character was described, these tentacles were always described as cylindrical, and sometimes as lacking of papillae (e.g., *Temnocinclis euripes* McLean, 1989 and *Temnozaga parilis* McLean, 1989; Hazprunar, 1989, although the affinity of these vent taxa currently classified in Scissurellidae is not adequately resolved).

Another anatomical character that proved to be useful as a diagnostic feature is the coiling pattern of the hindgut. The intestine is very long and forms several loops in all the species here studied, as well as in other species of scissurellids and anatomids for which the anatomy is known. The portion below the roof of the pallial cavity (the “hindgut”) shows different patterns in *Anatoma euglypta*, *Thielella amoena*, *T. weddelliana*, and *Scissurella clathrata*. Heath (1937) found in the genera *Nucula* and *Acila* (Bivalvia) that there is a correlation between length of intestine and depth at which species live; Sanders & Allen (1973) also noted a relative increase of the hindgut as size of some protobranch bivalves decreases. This seems to apply to the species considered herein: *Scissurella clathrata*, a shallow-water species, has a shorter and less twisted intestine than *Anatoma euglypta*, *Thielella amoena*, and *T. weddelliana* (all of them from deeper waters). However, it should be noted that these differences might be also related with the familiar assignment of these species (Scissurellidae vs. Anatomidae). Consequently, we consider that more detailed studies on this topic are required to confirm this observation.

Geographical Distribution and Ecological Patterns

The studied species showed varied distributional patterns, ranging from species with rather restricted geographic distribution to species widely distributed. Such species as *Anatoma shiraseae*, *Thielella weddelliana*, *T. argentinae*, *Scissurella obliqua*, *S. supraplicata*, *S. georgica*, *S. malvinarum*, and *Sinezona supraplicata* are known only from their type localities. These apparently restricted geographical ranges seemed to be a result of the limited knowledge from the Southern Ocean. *Scissurella clathrata* and *Anatoma conica*, two species known from many localities in the Magellan Region, may be also considered as belonging to the group of species with relatively restricted distributional ranges.

Ariella subantarctica occurred in two different areas: it was found both in true Sub-Antarctic waters (Macquarie Island, Crozet Island), and in the Magellan Region. A wider distribution was shown by *Scissurella petermannensis*, occurring at the Antarctic Peninsula, the Scotia Arc Islands (South Shetland Islands, South Orkney Islands), the Sub-Antarctic islands (Kerguelen and Macquarie), and the Magellan Region (Tierra del Fuego). Finally, *Thielella amoena* and *Anatoma euglypta* showed a circumantarctic distribution, the latter also spreading northwards, following Sub-Antarctic waters.

Four of the species present in the Antarctica belong to Anatomidae: *Anatoma euglypta*, *A. shiraseae*, *Thielella amoena*, and *T. weddelliana*; it is interesting to note that only one scissurellid species (*Scissurella petermannensis*) is known from this area. However, scissurellids are common in Sub-Antarctic waters, where they are represented by four species. A similar pattern occurs in the higher latitudes of the northern hemisphere: in Europe, scissurellids (*Scissurella costata* d'Orbigny, 1824, *Sinezona cingulata* Costa, 1861) extend as far north as the Iberian Peninsula but are unknown from the British Isles, Scandinavia and north thereof, whereas anatomids (represented by *Anatoma crispata*), are well known from the British Isles, Scandinavia, Faroe Islands, and Greenland. In the Northwestern Atlantic, the northernmost scissurellids (*Sinezona confusa* Rolán & Luque, 1994, and *Satondella tabulata* Watson, 1886) are described from Bermuda, while anatomids (*Anatoma crispata*) are known from much further north. In the eastern Pacific, scissurellids (*Sinezona rimuloides* Carpenter, 1865) is found in central California, while anatomids – *Anatoma “crispata”*, *Thielella baxteri* (McLean, 1984), *Anatoma janetae* Geiger, 2006 – are known from as far north as the Aleutian Islands. In the Western Pacific, the northernmost scissurellid is *Scissurella staminea* (A. Adams, 1862) from southern Japan, while *Anatoma disciformis* (Golikov & Sirenko, 1980) and *Anatoma s.l. obtusata* (Golikov & Gublin, 1978) are known from the Russian waters.

The other apparent ecological pattern found in anatomids is the strong tropical-polar diversity gradient. For instance, in the Indo-Malayan Archipelago eight species of this family are currently known, and there are approximately 25 additional undescribed species (Geiger, unpubl. data). The polar region, in contrast,

only contains four anatomid species in the Antarctic, and approximately the same number in the Arctic; the only species described in the Arctic, *Anatoma crispata* Fleming, 1828, has been applied to a great multitude of species (see Geiger & Jansen, 2004a), and its application particularly to North Pacific species is erroneous (Geiger, 2006b; unpubl. data). The intermediate areas, for instance the Mediterranean-eastern Atlantic region, contain approximately eight anatomids (Geiger, unpubl. data).

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